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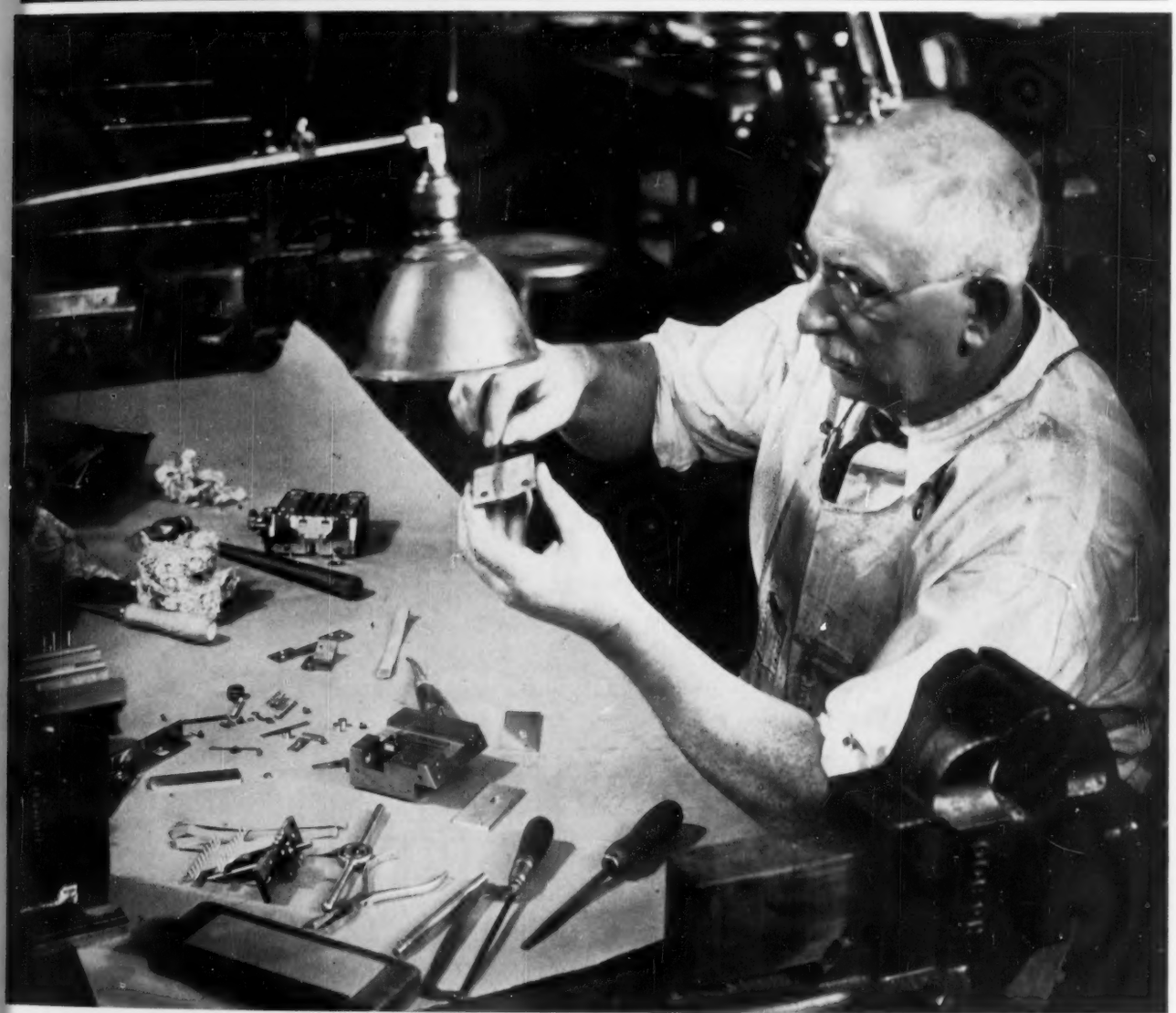
INSTRUMENTS

THE MAGAZINE OF MEASUREMENT AND CONTROL

VOLUME 5 FEBRUARY, 1932 NUMBER 2



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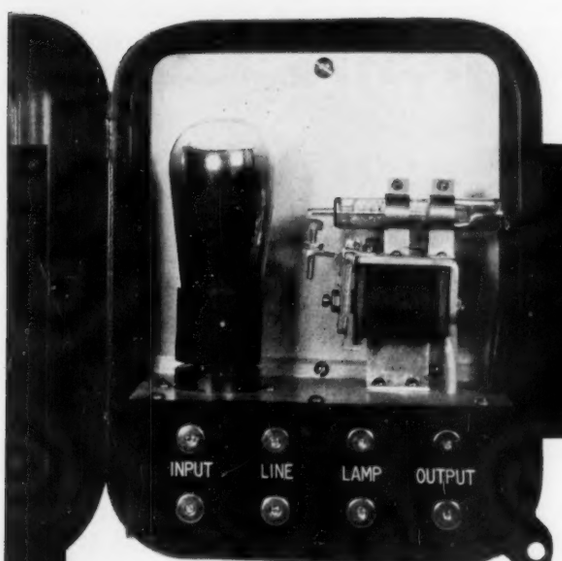

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Consists of electronic tube, and output circuit actuating relay provided with flame-proof and fool-proof Burgess Vacuum Contact. Available in 110-volt and 220-volt A.C. and D.C. types. Components mounted in steel cabinet with hinged front, measuring 7 x 8½ x 4¼ inches. Terminal strip inside box for external connections. 25-watt lamp wired in series with tube filament serves as resistor, pilot light indicating when relay is operative, and illumination for indicator instrument to which it is attached.

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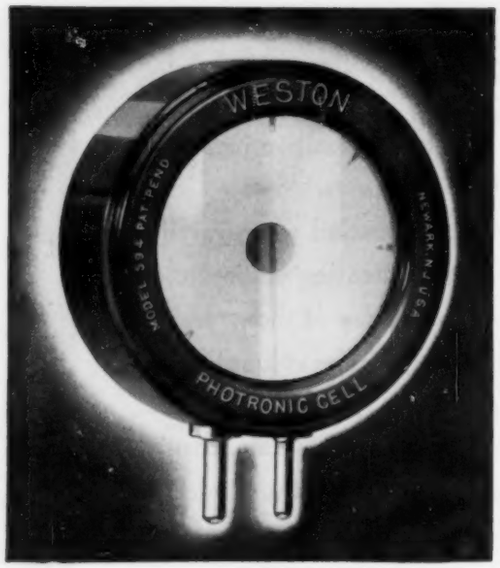

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Equipment for light sensitive cell applications is reduced, costs cut, installation and maintenance simplified by the new Weston Photronic Cell.

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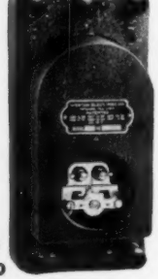
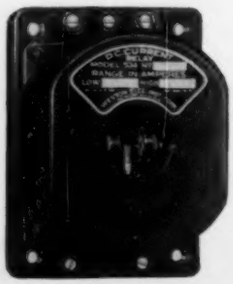


Precision Type RELAY Model 30



Sensitive Relay Model 534

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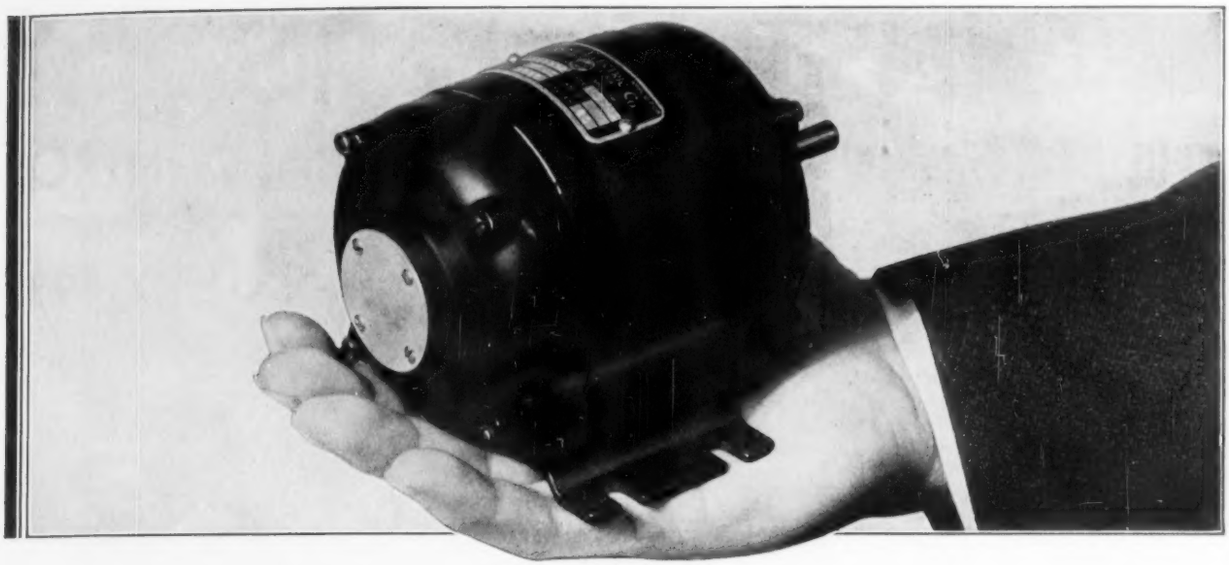

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There are hundreds of applications waiting for this small size synchronous motor. The ball bearings run without attention for years—an essential requirement for instrument and control apparatus applications used in continuous service.

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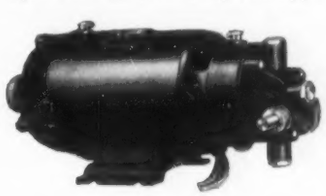

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INSTRUMENTS

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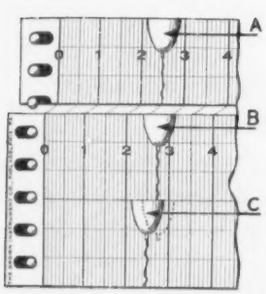
HUMIDITY COMPENSATED

WHY RECORDING POTENTIOMETERS NEED HUMIDITY COMPENSATION



Low humidity contracts the chart laterally, as shown by the chart section under pen A. High humidity expands the chart, as in the section under pen B. Pen A is positioned to record 250°. Expansion of the chart shifts the graduations relative to pen B, creating a change of 25°, 10% of 250°, or over 1 per cent of full scale, 2000°. The compensator adjusts pen B from the dotted line position C to the solid line position C, where it records 250° correctly.

All chart paper expands and contracts with change in the humidity of the atmosphere. Naturally a wide chart is desirable because closer readings can be obtained but a wide chart has greater expansion and contraction with change in atmospheric humidity. This expansion and contraction is the reason for the oblong holes on one side of a strip chart.

This effect of humidity changes may cause errors of more than 1% in the accuracy of the record produced by the recorder, unless proper compensation is made for the expansion and contraction of the chart paper. Such a compensator is built into the Brown Potentiometer. This compensator is an original development of The Brown Instrument Company—a basic improvement in recorders, fully protected by patent applications.

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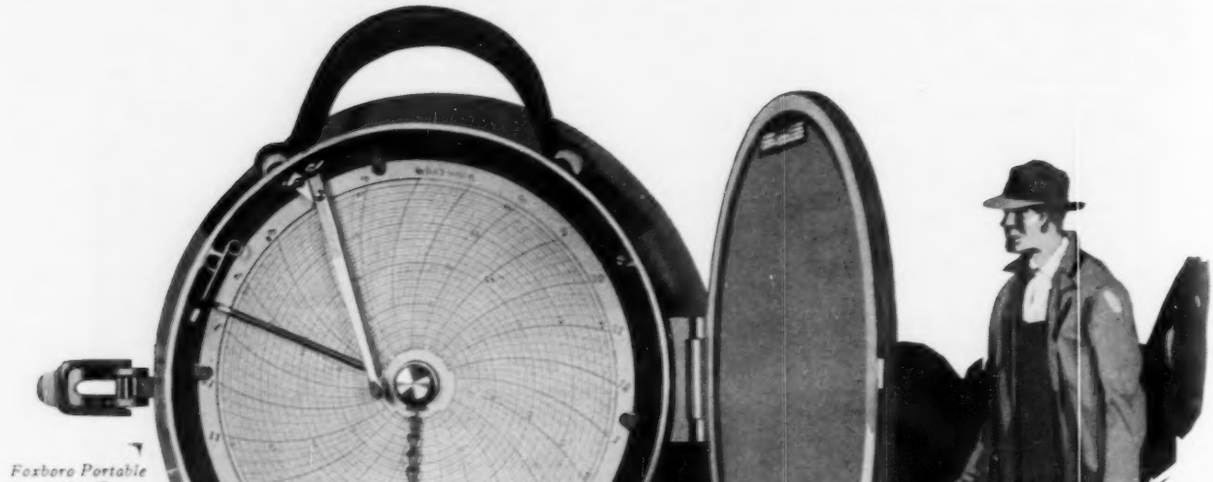
To Measure is to Economize

BROWN POTENTIOMETER PYROMETER

Brings Laboratory Accuracy to Industry



Foxboro Portable Recording Gauge

Portable Recorders

For running tests and periodic checking nothing is as satisfactory as Foxboro Portable Recorders. They are easy to handle, will stay in calibration, and cannot be readily damaged.

Thermometers, Gauges or Meters can be furnished in all-aluminum portable case. These instruments are rugged and light. They can be located in damp cellars or manholes without fear of injury. You can carry them anywhere —throw them in back of the Ford—or lug them over the trail.

The standard Foxboro movements are used in these portables. They are so **well balanced that no clamping device is necessary** when transporting the recorder.

Every plant should have these portables. They can be used as "extras" to be pushed into service should a regular instrument fail and as checking instruments, they are a sound investment.

Also Portable Thermo-Electric Pyrometers for high temperature measurement.

Write for complete information.

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EDITORIAL COMMENT

The Front Cover

ILLUSTRATION pictures "the man who builds measurement and control"—the instrument maker. This photo is reproduced by courtesy of The Magazine of LIGHT.

Last month's cover illustration—sorry it was not mentioned in that issue—showed the control and instrument board in the main operating room, Conowing Station of the Philadelphia Electric Company, by whose kind permission the picture was published.

◆◆◆◆◆

This Issue At A Glance

WHAT a **Plant Instrument Department** can and ought to be is told by Mr. Brown. He also tells how to establish, with strict economy, the nucleus of an instrument department and make it "show such dividends that the organization will support required expansion."

Incidentally, Mr. Brown's article forms part of the Behar *Manual of Instrumentation* which is appearing serially in INSTRUMENTS.

Measurement by radio—to a millionth of an inch, or even a hundredth of that, is a laboratory reality. Mr. Olken's article shows how the radio ultra-micrometer is growing out of the laboratory into general industrial application.

Engineering and development of **Knife Edge Bearings** is a neglected art points out Mr. de Juhasz, an expert on the subject. Then he shows where there is room for improvement, and along what directions improvement will come.

Growth has recently been very rapid along the electrical line in the field of industrial controlling equipment. Into what tendencies this growth is developing is set forth in the article on **Recent Trends.**

"Bigger and better testing machines" is the insistent demand of engineers. In the one described under **A Gigantic Testing Machine** it appears the engineer has attained all he could wish for.

◆◆◆◆◆

"Special"

WHEN manufacturers were busy producing standard items, anything special meant occupying time, facilities, or personnel that could be engaged in the more profitable production of standard units.

Not so long ago, therefore, anything "special" meant the purchaser had to make up in price what was lost in profit by withdrawing the manufacturer's personnel or equipment from the profitable "standard" production, to care for the "special" item. In industrial measurement and control equipment that was, sad to say, also the case.

We are glad to note, however, that in this respect the situation is changing, and has changed considerably already. Manufacturers looking for new products to take up look for such possibilities in the "special" items they are called on to produce. Others find they have staffs and facilities for development which it is desirable to keep going, and work on "special" items would keep them going.

"Special" items are therefore beginning to be favored, and in some cases even welcomed. One electrical instrument company for example, advertises "Not only does ——— offer a wide range of standard units, but ——— engineers gladly cooperate in the development of special instruments to meet unusual applications."

Get the habit to order "special" equipment to meet your industrial needs from the producers of similar standard equipment. Or else inquire of INSTRUMENTS. Our facilities for finding a manufacturer to produce your special item at reasonable cost are extensive, and always at your service.

◆◆◆◆◆

Meeting Specifications

TO meet the rigid specifications of component materials in many fabricating industries, a great amount of the product is manufactured, out of which is picked a small quantity good enough to meet the buyer's strict specifications.

This practice is economically unsound and inefficient. Too much low grade stock has to be produced to provide the quantity of the grade specified. This gluts the market for the lower grade stock; requires an excessive inventory of raw material to fill an order, and loads up the plant schedule and equipment with production that goes largely into storage.

Instead of meeting specifications by this practice of selection, it is better in every way to control the process so closely that the product is manufactured as well as the specifications call for. It is encouraging to find that the trend of industry is in just this direction, as we learn from the following quotation:*

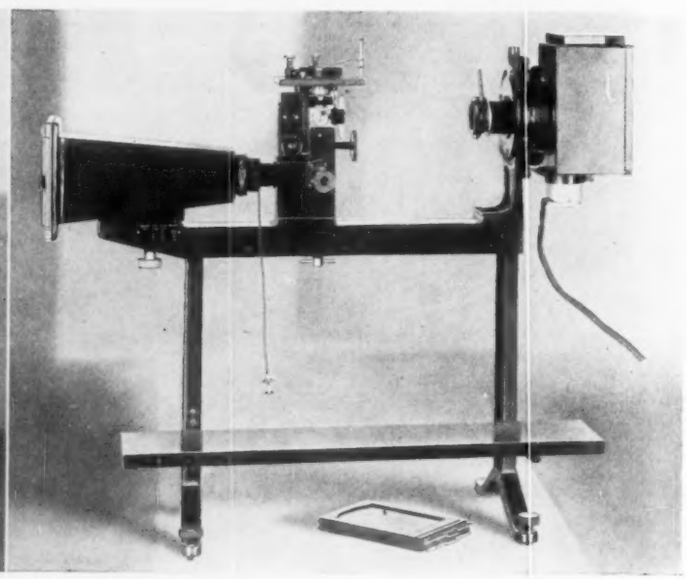
"The demands of large fabricating plants, such as automobile plants, and also the urge of close competition are bringing about a rather rapid, and in some ways remarkable, change in these conditions in that the large steel mills are being compelled to produce at their plants raw materials such as sheet, tubing,

(Continued on Page A21)

*J. C. Woodson, Industrial Heat Engineering Department, Westinghouse Electric and Mfg. Co., in paper "Electrical Heating for Metal Annealing Furnaces" presented before the Middle Eastern District Meeting of the American Institute of Electrical Engineers.

This Routine Metallographic Outfit Earns Extra Profits in the Laboratory

Small size and convenient adjustments make the SI ideal for quick, accurate examinations, both visual and photographic.



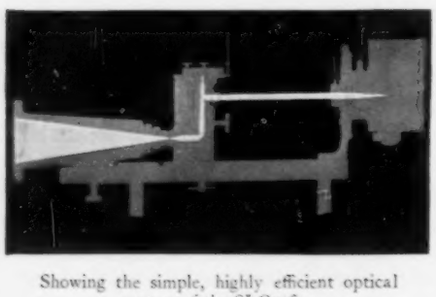
The SI Routine Metallographic Outfit. Note the simplified design and construction of this new table-model instrument.

THE SI Metallographic Outfit makes the inspection of metal characteristics a *routine* laboratory job. This simplified, table-model outfit is a real time saving tool, producing with speed, ease and accuracy, the finest of routine photomicrographs at standard magnifications.

The SI is mechanically and optically as fine an instrument as the Large B & L Metallographic Outfit, but in design, size, construction and price, it is specifically designed for daily routine examination.

The cast iron stand holds the camera, microscope and illuminating elements in rigid, *permanent* alignment, insuring *permanent* accuracy. The range of magnifications, from 25X to 500X, is standard as specified by the A. S. T. M.

Write for the new 128 page book "Optical Instruments for Examinin and Analysing Metals." It gives valuable information for the metallographer and describes the SI in detail.



Showing the simple, highly efficient optical system of the SI Outfit.

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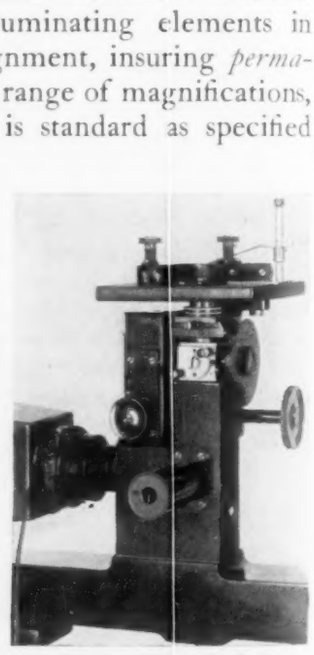
New 128 page book "Optical Instruments for Examining and Analysing Metals." Write for your copy.



The fine adjustment carries only the weight of the objective, and is so constructed that it is not affected by the heat from the illuminant.

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INSTRUMENTS

The Plant
INSTRUMENT DEPARTMENT

By ROY W. BROWN*

SUCCESSFUL organization of an instrument department in the average industrial plant necessitates convincing the management of the truth of Kelvin's famous statement, "Physics is the science of measurement." Conversely, measurement is science—hence an instrument department must be scientific. The scientific scope of an instrument department can be realized in a practical manner by assigning it such instrument maintenance, repair and construction, design and development, investigation and research as definitely lie outside of and beyond the scope of the usual master mechanics, or machine design and engineering departments.

Personnel and Equipment

Construction and repair personnel may be selected and developed from toolmakers and watchmakers while maintenance men may be selected from young pipefitters or automobile mechanics. Both groups will require continuous specialized education along the lines of their individual work. Physicists or engineers with extensive knowledge of physics provide most suitable material for intensive training as instrument engineers for design, development and research. Academic knowledge, while valuable, is less important than practical experience. Maximum coördination of instrument with other engineering work can be accomplished advantageously only with men having extensive experience. The field to be covered is so large as to require specialization by particular men on such items as flow meters, temperature measuring and controlling devices, electrical instruments or other instruments used in large numbers.

Floor space, machine tools and other required equipment will depend largely upon individual conditions. In general, machine tools should be restricted to such precision tools as jigs and fixtures, or those equivalent boring machines, lathes, shapers, grinders and milling machines especially adapted to small work which are not available in the plant, in its machine shops or tool rooms. A large percentage of instrument construction can be produced by the average machine shop, providing carefully detailed drawings and instrument engineering supervision are provided.

It is logical to concentrate in the instrument department the organization's working standards of length, weight, temperature, pressure and electrical units. Use of these necessitate a large amount of special precision, inter-comparison equipment which can be used very advantageously in developing improvements on production instruments and for the calibration of new or repaired instruments. Such precision equipment is also of advantage for experimental investigations such as temperature surveys, which could not otherwise be accurately accomplished. Experience has proven that extreme care in the design, construction and use of inter-comparison equipment will be well repaid.

The extent to which expansion of instrument divisions can be profitably carried depends largely upon the efficiency of the department. Expenditures ranging from 0.001 to 0.01% of gross sales would appear to be a reasonable figure for large plants. This figure may be increased appreciably with advantage for smaller plants if some of the engineering ordinarily done is combined with the instrument work. The floor plan illustration indicates approximate floor space and equipment requirements for large plants with instrument departments organized as outlined above. Large size and extensive equipment are not essential for the successful launching of a new instrument division. Correct special equipment intelligently and enthusiastically used will soon show such dividends that the organization will support required expansion.

Instrument work, requiring as it does personnel of highly specialized education and very specialized equipment, must—to function efficiently—be organized as a separate unit reporting directly to the plant manager, the chief engineer, or to the company official in charge of all technical and scientific matters. Such organization renders paramount the securing of facts as measured by instruments of known accuracies and minimizes individual haphazard opinion. It also minimizes the costly effect of "office politics" which unfortunately seems to be present in all organizations to a greater or less extent.

Instrument Engineering and Design

It is not sufficient to purchase an instrument and attach it to a machine or install it in the production department as one would another pipe fitting. The value derived from the same instrument can be doubled or trebled by: First, determining definitely if the instrument's characteristics of ruggedness, accuracy, sensitivity and readability are the best obtainable for that particular installation. Second, locating in such manner as to be easily and conveniently used by production personnel. Third, mounting in a neat, well appearing manner, providing special lighting and protection from drips or sources of dirt. Installation in this manner will invite and receive the respect of those who must use the instruments in their daily productive efforts, which results in greater and more intensive use with less abuse and much greater cleanliness.

*In charge of Engineering Laboratories, Firestone Tire & Rubber Co., Akron, Ohio.

Where a number of similar production units are sufficiently close together to come within the view of an operator, convenience can be greatly increased by grouping the instruments together within an elevated booth. Usually an appreciable decrease in production labor can be realized by combining remote, semi-automatic or full automatic control of the equipment with centralized instrument installations. In the installation illustrated, a group of eighteen tire vulcanizers are all operated from a centrally located booth in which are assembled instruments for recording and indicating temperature and pressure of the various process phases. Such installations, by increasing precision and uniformity of the process, result in improved quality of product.

Cabinet for Portable Precision Instruments for "Exchange" and Use by Entire Organization in Background. Right to Left is Equipment for Length Standards, Jeweler's and Other Fine Tools and Instrument Engineers' Desks.

Quantity purchase of a specific instrument can best be accomplished to carefully prepared specifications. Upon receipt of the apparatus, it should undergo inspection and calibration to definitely establish compliance with the stated specifications. With the exception of insisting on use of National Standard Screw Threads and dimensional interchangeability with other instruments in service, specified requirements should be confined largely to performance. This not only invites healthy competition but enables the vendor to take steps to eliminate the short-comings of previous instruments. These specifications should cover in detail such constructions as may appear necessary to eliminate faults which have developed in service.

Instrument engineering, as outlined above, will bring to light conditions previously undetectable by means of commercially available equipment, and will moreover make it possible to cope with such conditions. This need can be advantageously fulfilled by incorporating within the instrument department a design division arranged to collaborate with the maintenance, repair, construction and engineering divisions. In small plants these functions can be advantageously combined although this necessitates greater care in selection of personnel.

The ability to design permits working out, on an experimental basis, improvements in commercial instruments, which improvements, once made and demonstrated, are then adopted by the instrument manufacturers concerned.

It also permits the intensive development of auxiliary equipment especially adapted to individual requirements. It has been possible, for instance, to design and construct diaphragm-motor valve equipment at less cost which will operate several times as long without attention or failure. This greatly minimizes maintenance and—what is more important—reduces the amount of questionable quality product which usually results with the failure of any portion of automatic control equipment.

If extreme care and thoroughness is exercised in the design and development of special instruments, savings more than sufficient to cover the expense of the entire instrument department will result, and over a period of years a few fundamental instruments of acknowledged scientific value will be evolved.[1]

Inclusion of maintenance and design divisions within the same department provides incentive for correct and thorough design not otherwise obtainable. It has been found that this advantage—plus the advantages of highly specialized work, personnel and facilities—more than offsets the desirability, from an organization point of view, of combining all plant maintenance.

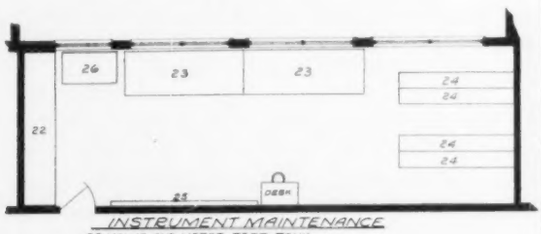
Instrument Investigation and Research

The material required for a good plant instrument department is ideally suited for an appreciable portion of investigation into the performance of production equipment, and for conducting researches which such investigations indicate to be desirable. A full appreciation of the measuring ability of instruments and of their mechanical or electrical limitations makes possible the carrying out of rapid and efficient investigation.

Such work also provides the maintenance and design divisions with information concerning plant processes not otherwise available, and which is indispensable to efficient work in these divisions.

Most industrial plants have a large amount of equipment not strictly instruments but closely allied thereto, such as steam traps, pressure reducing valves, and similar devices, the operation of which may affect the performance of control instruments attached to the same equipment. It therefore is necessary for the instrument maintenance man to determine the performance of this associated equipment before he can isolate the cause of a particular difficulty. Since the instrument man, if he is to function efficiently, is of a higher specially educated type than the average plant maintenance mechanic, it is logical to place the investigation of faulty operation of production equipment and of instrument controlled processes with the instrument department. The investigation facilities developed to meet routine requirements are well adapted for extensive investigation in determination of the exact performance of production equipment and processes.

Such an arrangement is particularly valuable in plants whose product requires a large amount of heat at a precisely controlled temperature. In this case investigation requires the use of a large number of precision temperature measuring instruments such as resistance thermometers and thermocouples, under extremely difficult plant conditions. Successful and inexpensive heat surveys in plant equipment are realized only with a great amount of ingenuity which is forthcoming only from extensive experience, both with the instruments to be used and with the equipment or processes in question. As previously mentioned, appreciable production labor savings can be realized by the combination of remote or automatic control processes with centralized instrument installations. While a large amount of such control equipment is commercially available, without exception it must be adapted to the individual application and in a large number of cases certain portions of the control equipment must be completely developed. A design division with its specialized knowledge of instruments and of the particular process is best equipped to undertake the development of the required control equipment. A large number of these problems are



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DAILY WORK ORDER AND RECORD

Information From ..... Dept. ..... Date .....

Time Received ..... Note ..... Interview .....

Description of Work or Trouble .....

Location - Building ..... Floor ..... Wing ..... Account .....

Time Assigned ..... Total Hrs. Today .....

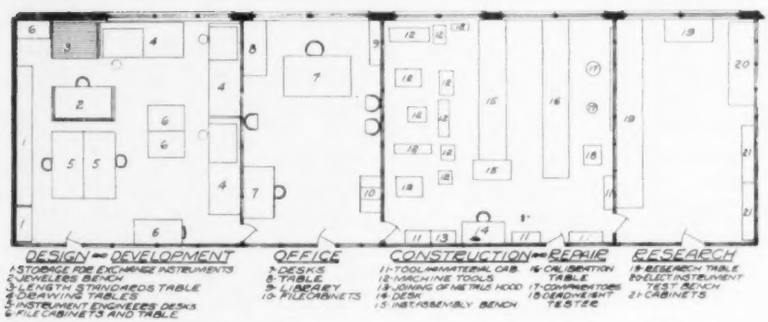
Time Finished ..... Foreman's Time .....

Remarks .....

6150

Signed ..... Workman

Approved By ..... Foreman of Dept. .....



(Above) Form Used to Provide a Complete History of Each Instrument Maintenance "Trouble Call."

(At left) Floor Plan of Modern Industrial Plant Instrument Department.

[1] *S.A.E. Journal*, Vol. XVII, No. 1, July 1925, page 113; *The India Rubber World*, July 1, 1927, page 197.

very complex and the advantages of a combination of control equipment units can only be realized through coördinated operation of all the units. Usually there are several missing links in this series which necessitate research before design can be undertaken. It therefore is advantageous to have facilities for such research immediately available in the instrument department. The research facilities, even in the case of large organizations, should be closely connected with the design division. In smaller organizations the two can advantageously be combined.

In the application of instruments, cases will arise where expenditure of large sums can be prevented by a thorough investigation of the working of the equipment upon which it is proposed to apply the instrument. Again intimate knowledge of both instruments and processes is required. As processes and plant equipment become more and more complicated, the savings to be effected by production instruments become larger and larger—hence increasing the need for coördinated instrument investigation, design, and research.

Instrument Repair and Construction

The instrument laboratory should be so equipped as to be able efficiently to construct a large percentage of instruments commonly used in the production department and should, if occasion arises, be capable of constructing to a fair degree of accuracy any type of instrument. The same facilities are equally well adapted for the repair of similar instruments. Usually it will be found advantageous to use to the maximum extent the plant machine shop and tool room or similar shops in the immediate vicinity, thus enabling the concentration in the instrument laboratory of such work as cannot be handled to advantage elsewhere.

Close contact between the design and construction divisions will render unnecessary the preparation of elaborately detailed drawings for the construction of experimental instruments and will enable the turning out of a surprisingly large amount of work. Pencil sketches attached to a routine work order assignment in addition to verbal instructions have accomplished mutual purpose with very little lost motion. If an experimental instrument placed in service proves satisfactory and additional similar instruments are required, then detailed drawings are prepared.

Repair work entering the laboratory is accompanied by a routine work order assignment and is allocated by the laboratory foreman as occasion arises.

The development of special fixtures and appliances adapted to the repair and calibration of production instruments used in large numbers permits the use of relatively unskilled personnel and results in a very low repair cost. Complete records of repairs are analyzed periodically and the design division advised of any systematic failures. Steps are then taken to eliminate or minimize the particular difficulty. Following repairs in this manner over a period of years will greatly decrease repairs and repair costs, also increase enormously the time an instrument will remain in a particular service without failure.

Plants using a large number of thermometers should be equipped with convenient and accurate comparators. These may be steam, oil or salt bath—depending upon the thermometer range. Care in design or selection of this equipment will result in reduction of calibration costs and will insure an accuracy of calibration not ordinarily obtained.

Numerous equipments are commercially available for pressure gage calibration. If the plant uses a recommended practice and purchases pressure gages on specifications, the calibration and repair operation will be simplified, as special checking fixtures can be used to determine the condition of the pressure-responsive element, enabling immediate scrapping of those gages, the elastic-members of which are no longer in serviceable condition.

Different plants will require different special repair and construction facilities dependent upon the number used of each type of production instrument as—vapor-pressure recording thermometers, potentiometer and resistance recorders, pressure gages, barometers, temperature controllers, etc. In providing watch repair equipment care should be used in selecting such equipment so as to best adapt it to somewhat heavier work than the conventional jeweler's watch repair. For example, the usual 1/100 HP 6000 to 8000 r.p.m. jeweler's lathe motors necessitate replacement with an approximately 1/6 HP 1800 r.p.m. motor. Similar staking tools should be selected for the larger sizes required in jeweled electrical instruments, thickness gages and factory clocks. Modifications along these lines will adapt a large amount of jeweler supplies to efficient repair and construction of aneroid barometers, stop watches, thickness gages and such special instruments of similar delicacy as individual plant requirements necessitate.

Medium and large size plants require compliance with established routine in the shipping and receipt of material. This not only represents a definite overhead cost but requires an appreciable amount of time. For this reason alone instrument repairs within the plant costing $5.00 or less will result in very appreciable reduced cost. Repairs above this amount are dependent upon efficiency with which the repair division is conducted, its special equipment and depreciation and write-off on the stock of instruments maintained for replacement purposes. It is probable that appreciable savings will result with the more expensive instrument repairs. The most advantageous factor is the prompt service which can be rendered, thereby enabling reduction of the number of replacement instruments to 1% or less.

Instrument Maintenance

If the plant covers an extensive area, it is desirable to locate the instrument maintenance division as close as possible to the production department in which the largest number of instruments is used. From time to time a large number of special records and work order form sheets have been evolved and used. Experience has indicated that a large number of special forms are not required for efficient practical mainte-

nance. A form similar to the daily work order and record illustrated, has replaced a far more complex form and has provided all the information which can be used in a practical manner.

This "Work Order" is partially filled out in duplicate at the time an instrument trouble call is received from the production department. The maintenance man answering the call takes the original with him and after making the repair, notes on the back of the form the condition and action taken. In the event the instrument is removed for repair or calibration, the "Work Order" form accompanies the instrument to the repair division. The repairs, after being completed, are also noted on the back of the form and the instrument and "Work Order" should be returned to the maintenance division for reinstallation or for replacement on other equipment. Thus the form is completely filled out at the completion of each job and constitutes a complete chronological record. The duplicates are checked against originals each day to determine if any are missing and also to determine the status of uncompleted trouble calls. The "Work Orders" concerning experimental or other instruments under investigation are filed separately and summarized as occasion demands, thus furnishing a complete history of the installation and performance of that particular instrument.

Recording instrument charts are preferably replaced on twenty-four hour intervals, dated and delivered to the production department or other departments concerned, after which they are returned and filed for a period of three months.

The maintenance division is also best adapted to handle, in a similar manner, installation of all new instruments and directly connected equipment. Shop facilities are provided for field installation by a specially equipped hand truck. This method has been found particularly advantageous in the large application of copper tubing on instrument services. Copper tubing has been found to entirely replace other forms of piping resulting in lower cost, better appearance and service.

Plants requiring a large amount of temperature control equipment necessitating the use of valves to control the heating supply medium will find it very desirable to equip the instrument maintenance shop with complete valve testing equipment. This is particularly desirable on control equipment on processes necessitating a dead-tight closure of the heating medium valve which is connected with remote semi-automatic or automatic equipment. Routine testing of valve equipment will also provide authoritative information concerning causes of failure, which information may be used by the design division in elimination of sources of systematic failure.

The necessity of simple routine and close contact between the design and maintenance divisions is emphasized, if systematic sources of failure are to be eliminated, quite forcefully in plants using a large number of temperature controls of the air relay type. In a typical case a large amount of maintenance of this type instrument was due to dirt included in the instrument air supply. Improvements upon conventional sources of supply minimized the quantity of dirt, thus leaving other troubles predominant. Design changes were made minimizing other troubles until today, though the major trouble is due to dirt in the instrument air, the total amount of trouble is less than 1% of that formerly existing.

Instrument Exchange

All plants have in various departments and laboratories certain portable instruments which are but very seldom used. These instruments can be advantageously grouped in the instrument department and loaned to the various departments desiring them. Such exchange results in providing each and all departments and laboratories with a range of instruments not otherwise obtainable. Also, each individual instrument is, by this method, used a much larger percentage of the time than would be the case if it were isolated in any particular department.

It is difficult to secure, particularly in medium and large size plants, the whole-hearted coöperation of the laboratory, production, engineering, general plant maintenance and other departments who have or who require occasional instruments. Arrangements to borrow from one division and loan to another division, handled quickly with a minimum of routine, have been found to be the best weapons in breaking down this prejudice.

A card index of all instruments available in the exchange should be maintained. The cards should carry complete information concerning the instrument so that the borrowing department can be immediately advised, usually over the telephone, concerning instruments available and the adaptation of such instruments to their particular requirements. Probably the simplest method of protecting the instrument from abusive use and correctly allocating the cost of repairs in the event of damage by abuse or accident is to require the issuance of a standard stores requisition. If the instrument is returned in good condition, the requisition is destroyed. If it is damaged upon its return, repairs or replacement charges applied against the stores requisition are forwarded through the factory accounting system in the usual manner.

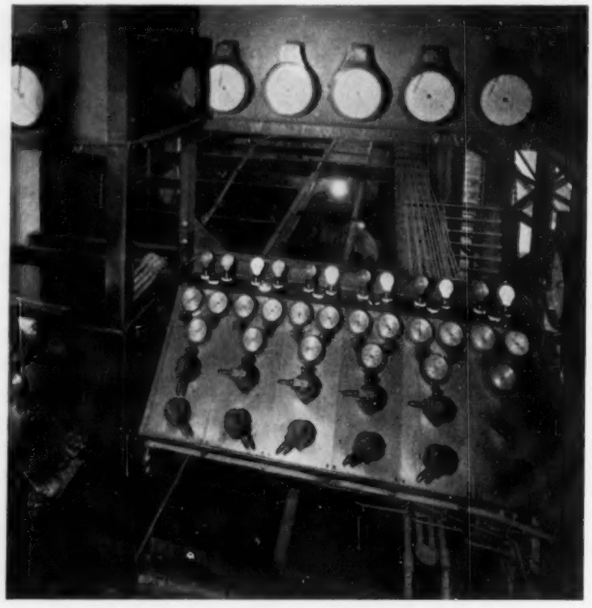
Over a period of a year such a system can be expanded advantageously to cover an extensive line of instruments, some of which, an oscillograph for instance, can only be used under the direct supervision of a representative of the instrument department. Others like precision potentiometers can only be loaned to persons known to be capable of intelligent use of the instrument. Voltmeters, ammeters, wattmeters, and similar electrical instruments which are used quite largely by plant engineers can be made available to all upon their authorization of an inspector or foreman.

The extent of satisfaction to be derived from an instrument exchange will be dependent upon the number and type of instruments available, the ease with which they are made available, condition of the instrument, and the dissemination of information con-

cerning instruments throughout the entire plant organization.

Power Plants—Instruments

It has not been many years since the only instrument seen about a steam power house was a steam gage, just as a shovel was the principal tool. Efficiency was an unknown word and the general opinion was that the power plant did not amount to much anyway. But those days are past for the modern plant. Under the stress of competition, a cost analysis of the product being manufactured often brought out the surprising fact that the cost of power was important, often the most important item, after the cost of raw materials.



Precision Vulcanization of Tires is Secured through the Centralization of Instruments. Remote and Automatic Control Equipment Shown.

Similarly it became generally known that a workman with a plentiful supply of cheap kilowatts could produce more and at less cost than could several workmen without the power. Then attention turned to the power plant, so that today practically all instruments for power house operation can be purchased on the market from competitive makers, leaving little to be required of the plant instrument man from the standpoint of design.

The plant instrument man should consider the power plant as one of his most important charges, from the standpoint of recommendations for the purchase of the proper instruments and automatic devices. Moreover, he should base these recommendations on economics. If the interest and depreciation plus maintenance on a device is less than the labor and material saved and it will help do a better job, then there is a place in that plant for that instrument. When we say maintenance we mean good maintenance, for an instrument in error is worse than useless, once the habit of placing reliance on its indications has been established.

It will be necessary that a definite line be established between instruments in the care of the factory instruments division, and fittings or appliances in care of the operating maintenance personnel.

Generally speaking, such instruments as draft gages, stack pyrometers, thermometers of various kinds, combustion control equipment, pressure gages, remote indicating devices and electrical indicating and recording devices of various kinds should be in charge of the instrument division, while feed regulators, pump governors, damper regulators and water gages should be under the operating men.

Safety valves may be included in either group, but it appears more desirable to place them under the instrument division.

The inspection of these instruments and devices can well be a daily affair and can be undertaken by the instrument division as a part of its chart changing work without loss of time or increase of personnel, the reports to go daily from this man to the operating maintenance division.

In general the specification of the various instruments at the time of installation has been handled by the power plant designing staff, since they have become fairly well standardized on the market. Even if this be so, the approval or advice of the instrument division will be useful and it might be said, necessary to a completely successful installation.

◆◆◆◆◆

AN exhibit of a very extensive line of motor control equipment is announced for the four weeks beginning February 1, 1932, by the Allen Bradley Co. of Milwaukee, Wisconsin. The fifth floor of the Engineering Building, 205 West Wacker Drive, Chicago, has been reserved for this display. Included in the display will be representative items of the company's entire line of motor controllers and accessories.

◆◆◆

Bailey Meter Company, 1050 Ivanhoe Road, Cleveland, Ohio, announce the appointment of W. J. Reeder as manager of its St. Louis Branch Office. This appointment fills the vacancy made by the untimely death of Mr. C. J. Prendergast, which resulted from injuries received in a building collapse at Paoli, Indiana, a short time ago.

The American Kron Scale Company, manufacturers of all types of heavy duty automatic dial scales, has recently been reorganized under the name of "The Kron Company." The reorganization was decided upon to provide additional capital for use in broadening the lines of manufacture and increasing the activities of the company. The plant has been moved from its old location in New York City to 1720 Fairfield Avenue, Bridgeport, Conn., where larger and more adaptable space is available.

Mr. Richard F. Straw, associated with the Wright Manufacturing Company since the war has resigned his position as sales manager to become president of the new organization. The other officers are F. W. Dee Foe, vice president and H. C. Stevenson, secretary and treasurer.

ULTRA-MICROMETER
Measurement by Radio

By H. OLKEN*

A MINUTE change in the distance between plates of a condenser produces a considerable change in the condenser capacity.† Combine this with the extraordinary sensitivity of radio methods for measuring capacity changes, and one has a means of measuring distances that are almost inconceivably small.

Several methods have been developed for fine measurement by capacity changes. Of late so much progress has been made in the perfection of these methods that a brief survey of the art of measurement by radio-indicated condenser changes is now in order.

Dowling

Simplest of the ultra-micrometers so far developed is that of Dowling.[1, 2] In the tuned circuit of a simple vacuum-tube oscillator (Fig. 2) is a variable condenser, C_x, one of whose plates is fixed while the other moves with the displacement to be measured. The capacity changes of this measuring condenser change the frequency of the oscillator, and consequently its steady plate current. The changes in the steady plate current are, over a certain range, proportional to the motion of the movable condenser plate. A potentiometer arrangement bucks out the initial current, so that galvanometer G reads only the *changes* of plate current.

With different oscillator circuit arrangements, and different tube voltages, a wide range of sensitivities is obtainable, as well as different degrees of linearity for the plate current-condenser spacing curve. Obata, who has developed the Dowling method to a high degree,[3] obtained a maximum workable sensitivity of about 20 millionths of an inch per mm. galvanometer deflection. Of course the sensitivity increases as the condenser plates get closer together, for then each mm. displacement of the movable plate produces a greater change of the condenser capacity (Fig. 1).

The table herewith from Obata shows clearly how the sensitivity changes with the condenser plate-spacing.

Initial Air Gap	Displacement per mm. Deflection	Magnification
0.5 mm.	0.00077 mm.	1,300
0.3 mm.	0.00037 mm.	2,700
0.08 mm.	0.00004 mm.	25,000
0.06 mm.	0.00002 mm.	50,000

Descriptions and results are given by Obata for application of the Dowling ultra-micrometer to measuring seismograph vibrations, internal combustion motor pressures and acceleration. Ekelöf[4] later applied this ultra-micrometer to measuring the vibra-

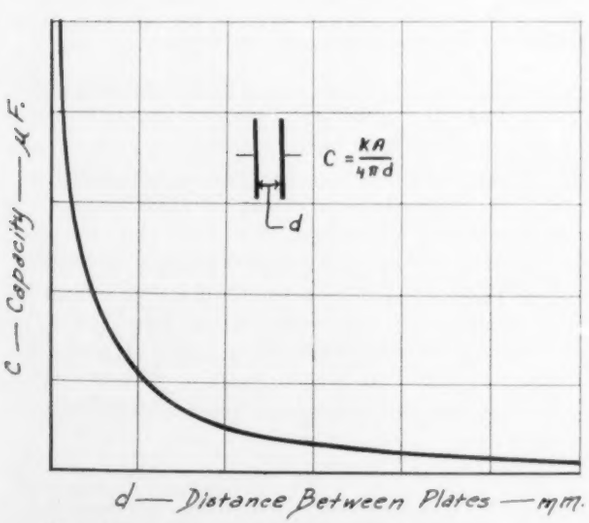


Fig. 1. The Basis of Radio Ultra-Micrometers—the Condenser Capacity-Spacing Curve.

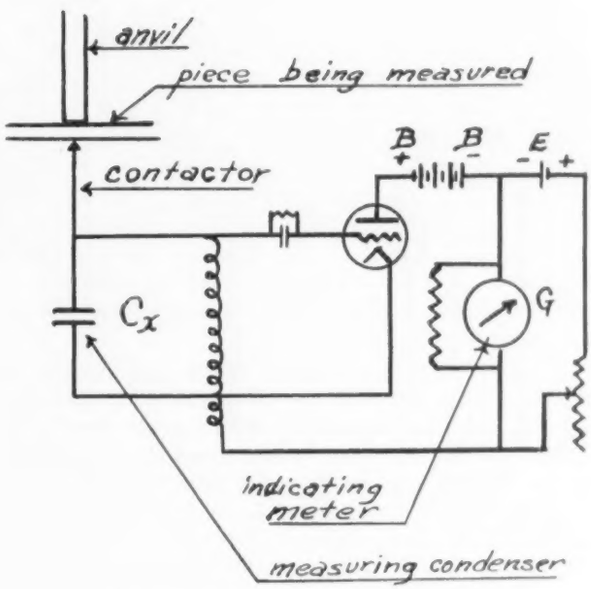


Fig. 2. The Dowling Ultra-Micrometer.

*Engineering Editor.

†This is apparent from the relation between capacity and plate spacing of a parallel plate condenser: $C = KA/4\pi d$ where

A = areas of plates
K = 1 for air
d = spacing between plates.
See Fig. 1.

tions causing fatigue in metals. He found that the smallest distance which could be measured with his set-up, if one wanted to split hairs that fine, is 10^{-6} mm., or something shorter than one hundredth of a millionth of an inch!

Resonance

When a tuned circuit is near resonance, a slight change, $\triangle C$, in its capacity produces a great change in the amplitude of the current through the circuit, or the voltage across it (Fig. 3). Using the resonance curve of current or voltage to give amplified indication of changes in the measuring capacity, several ultra-micrometers have been developed. One by H. Gerdien, [5] first rectifies the r.f. amplitudes, then indicates the variations by a millivoltmeter. This instrument was used to measure the torsion in a rotating shaft. Another application by H. Thoma,[6] amplifies the resonance amplitude changes, and observes them through an oscillograph. This form of ultra-micrometer is particularly adaptable for the study of minute, momentary motions such as shaft vibrations, lathe-tool pressure variations, and explosion pressures.

The circuit-resonance type of ultra-micrometer in its most practical form are the commercial machines of Fig. 4, both produced by the same company[7]. C_x, the measuring capacity, is in a tuned circuit coupled to an oscillator. (Fig. 5.) Current amplitude in the coupled circuit is measured by a thermocouple Tc, and a millivoltmeter MV.

Certain patented features[8] insure accuracy even under variations of line voltage, power factor, and load. The oscillator tube serves also as half-wave rectifier for its own plate voltage, so no separate power supply is needed. Meter indications are about ½ inch deflection for a millionth inch movement of the condenser plate, so amplifying stages are unnecessary. Using only one tube, this ultra-micrometer is therefore so simple, compact, and rugged, that it makes a reliable instrument even for industrial plants. It is particularly useful for checking gages in machine shops.

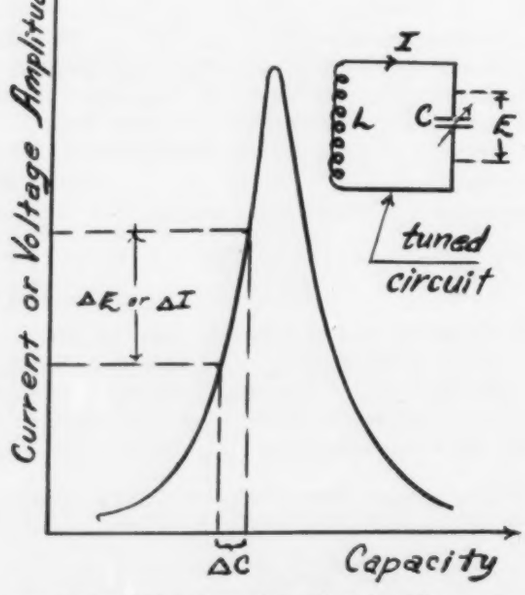


Fig. 3. Illustrating Operating Principle of Resonance Ultra-Micrometer.

Heterodyne

Capacity ultra-micrometers have also been devised on the heterodyne principle. A known relation exists between the frequency f_1 of an oscillator such as oscillator 1, Fig. 6, and its tuned-circuit capacity, C_x. Roughly the relation is $f = K/\sqrt{C}$ where K is a constant. If f_1 is 1,001,000 cycles per second, even 0.001% change in C_x will vary f_1 by several cycles. Heterodyning makes it possible to detect these few cycles of frequency difference in such a way that they can easily be counted. In Whiddington's set-up,[9] these few cycles of frequency difference are counted as beats heard from a loud speaker.

The heterodyne process as employed by Whiddington works as follows: Suppose the micrometer contact pin of Fig. 6 is moved a minute distance, and we wish to measure this distance. The contact pin has moved one plate of C_x with it, the resulting change in C_x changing f_1 to a new frequency, f'_1, of $(1{,}001{,}000 + x)$ cycles per second. f'_1 is impressed on circuit D, where it is modulated with a constant known frequency f_2, of 1,000,000 cycles, from a standard oscillator, Oscillator II. Circuit D will then oscillate electrically at frequency f'_1, but the amplitude of this oscillation will vary periodically, at a frequency f_h, where

$$\begin{aligned} f_h &= f'_1 - f_2 \\ &= (1{,}001{,}000 + x) - 1{,}000{,}000, \\ &= 1001 + x \text{ cycles per second.} \end{aligned}$$

A detector will pass only this amplitude oscillation, f_h, into circuit E. Here f_h is modulated by a constant 1000-cycle frequency, f_3, from Osc. III. As above, an amplitude variation of f_h results at a frequency f_x, such that

$$\begin{aligned} f_x &= f_h - f_3 \\ &= (1000 + x) - 1000 \\ &= x \text{ cycles per second.} \end{aligned}$$

The loud-speaker L_s follows only the amplitude oscillation in circuit E—that is, f_x. Consequently, by listening to the loud-speaker with a stop-watch, we count the number of cycles per second, x, which, added to the initial known frequency f_1, gives us the unknown frequency f'_1.

Knowing f'_1, we derive from the relation between f and C the new value of C_x. This, when used in the equation for C as a function of d will give the new plate spacing. The difference between the original plate spacing and this new value is the distance moved by the micrometer contactor.

Modifications of this method using different means for measuring the few cycles of frequency change have been developed. In one modification* by Loebe and Samson,[10] the frequency change, translated into a current amplitude, is measured continuously and without aid of the human ear. It is thus the most practical of heterodyne ultra-micrometer methods.

The limit of sensitivity for the heterodyne method is set primarily by the difficulties of keeping the frequencies of two oscillators regulated to about one part in a million. Also, the apparatus is complicated, and frequency measurement of the beat note is incon-

*Loebe and Samson use a fixed circuit C, Fig. 7, tuned to 1000 cycles per second, to receive the heterodyne note f_h. The voltage created across this circuit is of frequency f_h, but its amplitude will vary along a resonance curve as f_h deviates from f_3. This voltage amplitude variation is amplified, and converted by a detector into current indications of a meter. This meter can be calibrated to read motion of the micrometer contactor in millionths of an inch.

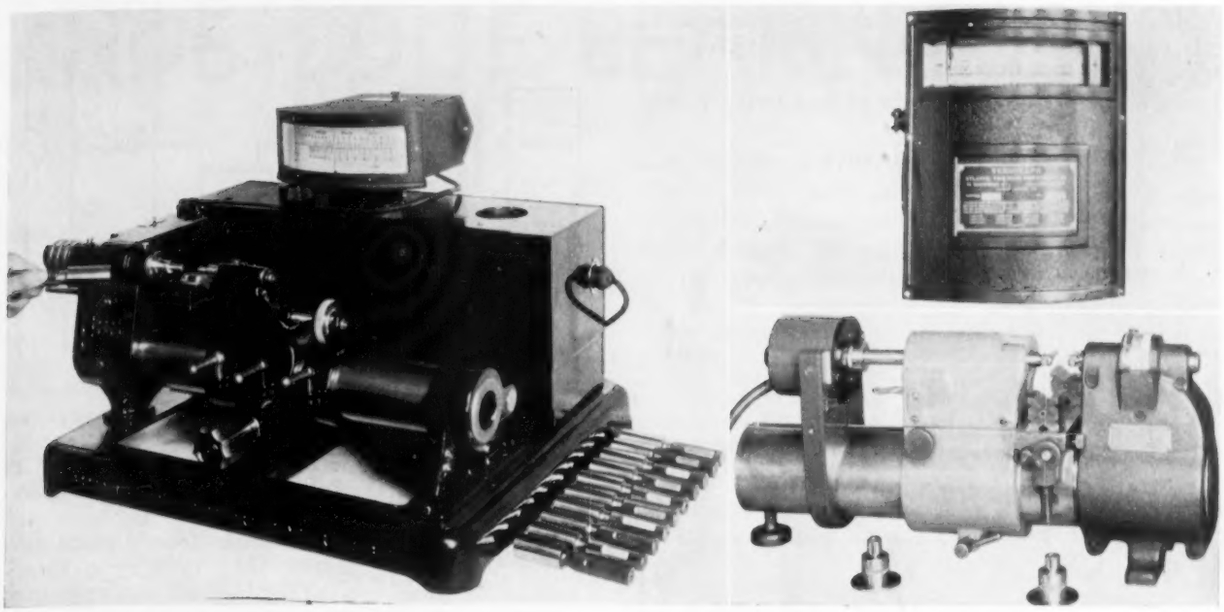


Fig. 4. Two Industrial Forms of the Resonance Ultra-Micrometer Machine—at Left—all Elements in One Complete Unit. Machine on Right—Indicator in Separate Unit Above, Mountable Where Convenient to Read.

venient. Nevertheless, these practical difficulties are not too serious, and the method affords such extraordinary sensitivity that it has been successfully adapted to measuring the slippage of metals under stress, [3] the measurement of weights to millionths of a gram, [1,2,9] and the measurement of temperatures to 1/16,000 °C.

Other Methods

Notable among still other capacity-measuring methods [12,13,14,15] utilized for ultra-micrometers is a recent German development of the bridge type.[15] The basic aims of this design were: (a) to eliminate errors from mechanical disturbances of the moving plate; (b) to get a straight line relation between indicator reading and distance moved by the condenser plate.

Using a condenser of two fixed plates with a movable one midway between for measuring head, and a vacuum tube bridge as indicator (Fig. 8), both these aims are attained. The three plate condenser is equivalent to two condensers in series, whose differential voltage is proportional to the distance moved by the middle plate away from center. The vacuum tube bridge used indicates this differential voltage on a meter I, hence the meter reads distance moved by the middle plate.

Stray effects such as temperature variations, misalignment of plates, etc., are neutralized by putting both halves of the 3-plate condenser in this "differential" arrangement. The bridge arrangement of the vacuum tube indicator provides a linear relation between meter reading and distance moved by the center plate.

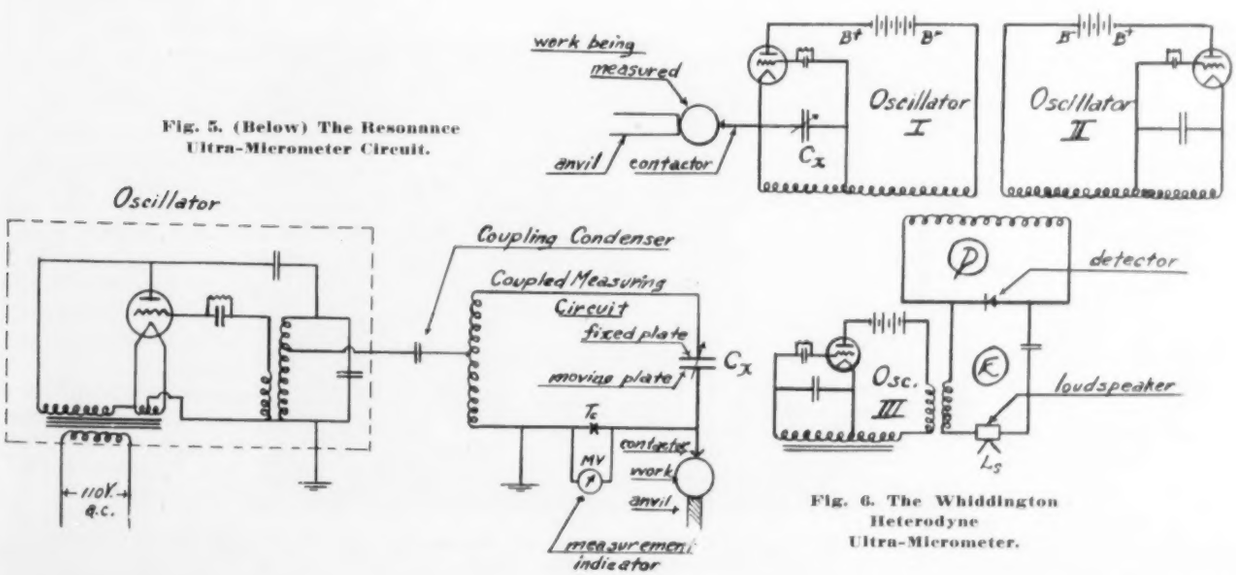


Fig. 5. (Below) The Resonance Ultra-Micrometer Circuit.

Fig. 6. The Whiddington Heterodyne Ultra-Micrometer.

Maximum sensitivity with this ultra-micrometer, using a galvanometer giving 1 mm. deflection for 10^{-7} amperes, is deduced as 0.5 (10^{-6}) cm. By special condenser construction this can be pushed to 0.1 (10^{-6}) cm.

This brief survey shows that radio-operated capacity ultra-micrometers are passing out of the last stages of laboratory development into the first stages of technological application. Measurements finer than a millionth of a centimeter are thereby made practicable. As yet, applications of such fine measuring devices to the study of phenomena where ultra-fine dimensions are involved, such as vibration of shafts,[6] elongation, elasticity, and plant growth,[2] etc., have only begun to be made. With ultra-micrometers developed as they are today, this field may soon be closely scrutinized, and many of nature's ways heretofore too fine for human observation may soon be revealed.

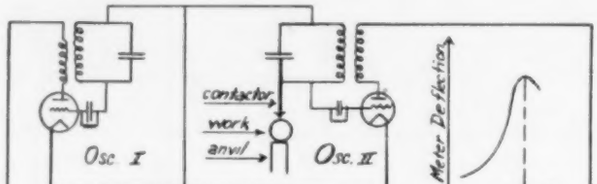


Fig. 7. Loebe and Samson Heterodyne Ultra-Micrometer.

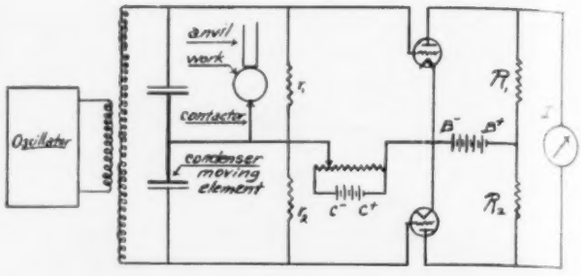


Fig. 8. Reisch Differential-Capacity Ultra-Micrometer.

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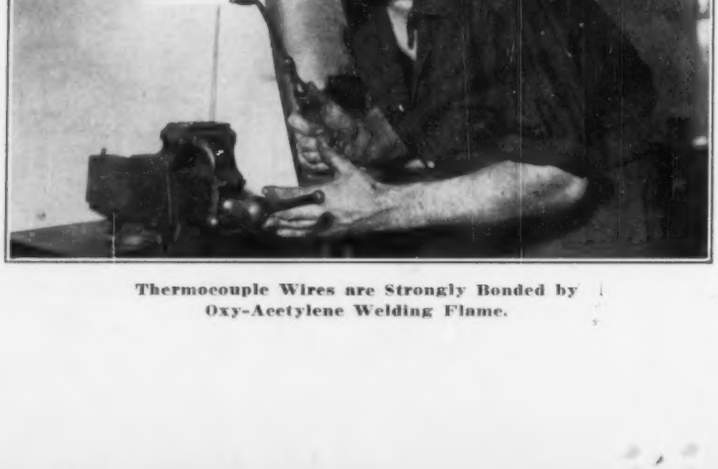


Thermocouple Wires are Strongly Bonded by Oxy-Acetylene Welding Flame.

KNIFE-EDGE BEARINGS

By KALMAN J. DeJUHASZ*

THE use of knife-edge bearings on scales dates back to the Romans. Since then they have found increasing usefulness and today they are extensively employed as an axis for a lever arm or a beam, wherever the lever must have an oscillatory movement through a limited angle, with the least amount of friction. Their main field of application is therefore in the construction of balances, scales, weighing and testing machines.

In spite of its antiquity and technical importance, the knife-edge bearing did not share that high degree of development which other elements of machinery underwent since their inception in a crude form. A comparison suggests itself with the other types of bearings, which are also elements of great antiquity, and serve a similar purpose. From the early type of bearing which was nothing more than a hole into which a pivot was inserted, were evolved the refined sliding bearings and the highly developed and standardized rolling (ball, roller and needle) bearings of today. Also the theoretical background relating to the action of bearings is well cleared up, and still forms the subject of thoroughgoing research. Compared with this progress the knife-edge type of bearing is in a rather backward stage of development, and even in otherwise well thought-out and carefully constructed machines one can often find extremely crudely designed and manufactured knife edges. As far as the author could ascertain, no theory exists for the stresses in knife edge bearings, and no research is being carried out to remedy this deficiency.

In view of its wide field of application, it seems to be of interest to survey the present practice in the design and applications of the knife-edge bearing and to point out some directions in which its further development might take place.

Strength Properties. Very little is known of the dependence of the bearing capacity, sensitivity, and useful life of a knife-edge bearing on the dimensions (length, width and inclosed angle) of the knife-edge pivot and its bearing seat. Yet such a knowledge would be of great importance because a weighing machine is no better than the knife edges which are incorporated in it.

It is known qualitatively that the greater the width of a knife-edge, the larger its bearing capacity; the narrower the width, the greater is the sensitivity. Increasing the enclosed angle of the faces also increases the bearing capacity, but diminishes the angle of possible oscillation of the beam. Increasing the length of the knife-edge increases the bearing capacity, but introduces also a possible error from deflection unless its cross sectional area is also increased, or special precautions are taken in the design to support the edge along its entire length.

Quantitative values on the dependence of the performance characteristics on the design data are, however, very scarce in the technical literature, and even those available are so insufficiently substantiated by experiments that they amount to hardly more than a rule of thumb. For example, the *Encyclopedia Britannica* (XI Edition: Balance) gives the following figures:

1. For scale beams of the highest accuracy: from 0.5 to 25 lbs./in. (up to 0.5—80 lbs. capacity).
2. For ordinary trade scale beams, counter machines and deadweight machines: from 20 lbs./in. (7 lbs. capacity) to 600 lbs./in. (1000 lbs. capacity).
3. For platform machines and weigh bridges: 120 lbs./in. (4 cwts. capacity) to 1 ton/in. (25 tons capacity).

Kent's Handbook (10th edition, page 1621) states as allowable limit 5000 lbs./in. for ordinary weighing and testing machines, and even 10,000 lbs./in. as permissible, provided the knife edge is supported over its whole length. For loads up to 1000 lbs./in., the edge may be perfectly sharp. For greater loads a slight rounding of the edge with oilstone is recommended.

There is a growing recognition of the need for a systematic research in this important field. An outstanding contribution is a recent paper by W. M. Wilson,* in which the most urgent problems of knife edge design are summarized as follows:

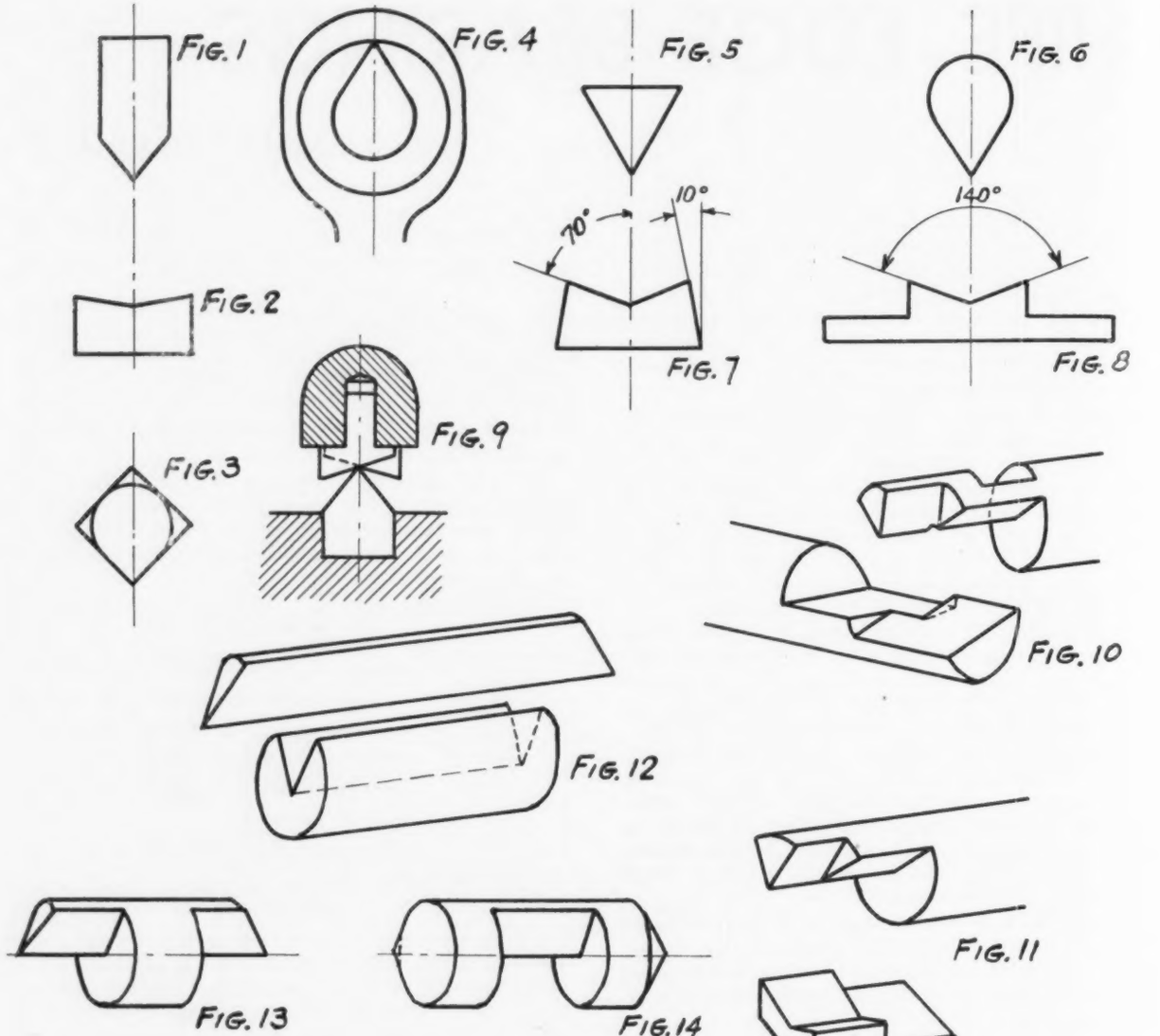
1. How is the bearing value of a knife edge affected by:
   a. The angle between the faces of the edge?
   b. The width of the edge?
   c. The physical properties of the material?
2. What is the effect upon a knife-edge of:
   a. Impact?
   b. Horizontal forces acting simultaneously with vertical forces?
   c. Wear due to the rotation of a lever about a loaded knife-edge?
3. Should the knife edge and the bearing block have the same physical properties? If not, which should be harder?
4. How is the constancy of the multiplication ratio of a lever affected by:
   a. The width of the knife-edge?
   b. Depressions on the plane surface of the bearing block?
   c. Distance between adjacent knife-edges?
   d. Anguiar movement of the lever?
   e. Magnitude of the load?
5. What provision should be made to insure uniform distribution of pressure along the knife edges of straight levers?

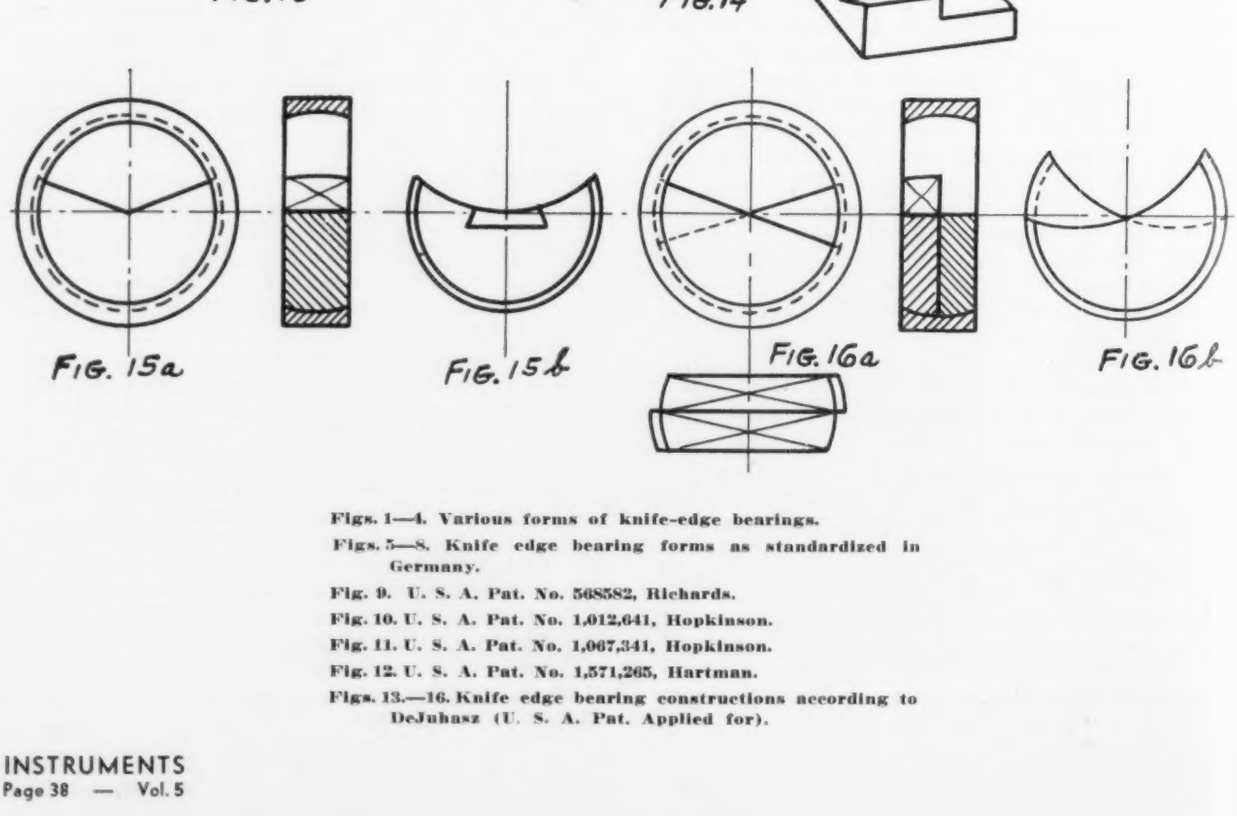
The theory underlying the bearing capacity and stress distribution of a ball or roller bearing is well understood owing to the theoretical work of Hertz and the experiments of Stribeck, and others. For the knife edge no such theory seems to exist. Probably a research on the distribution and intensity of the stresses could be successfully undertaken by the photo-elastic method developed by Coker. Such a research on various forms of knife edges and their seats would be very valuable for their design and application.

Materials. In order to provide the required bearing capacity with the greatest possible sensitivity, it is necessary to employ hard materials. Therefore in analytical balances of small capacity semi-precious stones are used. Russian agate is considered best. In large weighing machines hardened steel is used exclusively, usually a high grade uniform tool steel with 0.90 to 1.00% carbon content. It is probable, however, that the recent advances made in the field of metallurgy provide a material better suited for this purpose, such as chromium plated steel, nitrided steel, Stellite, Carboloy, Widia metal, or the like. It is true that these materials require in their manufacture specialized treatment and thorough knowledge of their peculiarities, so that their manufacture could not be, as a rule, successfully undertaken by the manufacturers of machines themselves. But then, perhaps the manufacture of knife-edge bearings should be the job of a specialty manufacturer, just as ball bearings, chains, piston rings, spark plugs, etc., are manufactured in special plants to the advantage of makers and users alike.

*Assistant Professor of Engineering Research, The Pennsylvania State College.

*"Some Questions Pertaining to the Design of Weighing Machines," *Scale Journal*, March 10, 1930.





Figs. 1—4. Various forms of knife-edge bearings.

Figs. 5—8. Knife edge bearing forms as standardized in Germany.

Fig. 9. U. S. A. Pat. No. 568582, Richards.

Fig. 10. U. S. A. Pat. No. 1,012,641, Hopkinson.

Fig. 11. U. S. A. Pat. No. 1,067,341, Hopkinson.

Fig. 12. U. S. A. Pat. No. 1,571,265, Hartman.

Figs. 13.—16. Knife edge bearing constructions according to DeJuhasz (U. S. A. Pat. Applied for).

Design and Manufacture. There is a great variety of shapes and dimensions of knife-edges. Every manufacturer of scales and weighing machines makes his own knife-edge pivots and the corresponding bearing plate. Some examples are shown on Figs. 1-4. These are inserted into their respective holes or recesses which are usually broached to the corresponding shape, and then are jammed into place. It is a requirement that the edges should be truly straight, those in one beam strictly parallel, and placed at the proper distance from one another to give the required leverage. Furthermore, in most cases the 3 edges in one beam should all be in one plane when the lever is fully loaded. At the present all these requirements are taken care of by careful stoning and other adjustments after the pivots have been fixed into place. This is a laborious procedure, but is held by scale makers to be necessary for the best results. Whether this view is correct, or merely a prejudice hanging over from earlier times when accurate machining methods were not available, is open to question. The writer leans to the view that the present necessity for hand adjustment is largely the consequence of insufficient accuracy in making the knife-edge and preparing the hole into which it is to be inserted. The crude workmanship which one can see in some otherwise well made weighing and testing machines seems to corroborate this view.

Knife-edge bearings have not yet been standardized in this country, though a few forms of it have been standardized in Germany. Fig. 5 shows the equilateral triangle, and Fig. 6 the pear shaped, knife edge. Fig. 7 is a seat form for dovetail insertion, and Fig. 8 is a form to be bolted on by means of a flange.

Figs. 9-12 show a few patented forms. The Richards patent (Fig. 9), has for its object the provision, as a seat, of a truly straight line, attained by the intersection of 2 or more blocks arranged alternately in 2 inclined planes. Each block is rotatable so as to find its correct position under the influence of the knife-edge force.

The Hopkinson patents (Figs. 10-11) have for their object the provision of a large oscillating angle without the danger of the knife-edge slipping out of its seat. In Fig. 10 this is attained by 2 knife-edges displaced at an acute angle with reference to each other, their edges being in one straight line, and engaging with 2 plane surfaces displaced with the same acute angle with respect to one another. In the arrangement shown in Fig. 11 the same object is sought by means of 2 adjoining knife-edges with a common edge, one of them having a narrow inclosed angle and engaging with a notched seat in order to prevent slippage, the other having a wide enclosed angle and engages with a plane bearing block, to provide the required bearing capacity. The common disadvantage of these forms is, apart from their cost of manufacture, their great length, through which a liability to bending is introduced.

The Hartman patent shown on Fig. 12 has for its object to insure that the edges of a divided knife-edge pivot fall in one straight line. This is attained by placing a blade of continuous knife-edge into a corresponding recess formed in a cylindrical piece. The assembly of these 2 pieces is placed into a cylindrical hole in the beam and secured there by suitable setscrews.

The author has no knowledge of any of these knife edges being used to any considerable extent.

Figs. 13-16 are taken from a recent patent application of the author. The underlying endeavor was to develop types of knife-edge suitable for standardization, and for interchangeable manufacture by mass production methods similar to the manufacture of ball and roller bearings. With this aim in view the knife-edge pivots have a cylindrical portion, as shown on Figs. 13 and 14 which can be fitted with a push or drive fit into the bored and reamed hole in the beam. The knife-edge lies preferably in the geometrical axis of the cylinder, whereby a turning moment on the pivot is eliminated. Furthermore extreme care in the insertion of the pivot becomes unnecessary, because differing angular positions of the pivot do not affect the position of the axis of motion and therefore do not alter the ratio of leverage. However, in cases where a slight adjustment of the leverage ratio has to be provided for, it is possible to make one of the pivots with an edge slightly off center. Then a slight rotation of the pivot in its hole will bring about a modification of the leverage ratio. The sharp end-points of the pivot serve for endwise positioning without friction, with the aid, for example, of 2 suitable stops which limit the possible axial movement of the knife-edge.

In a similar manner, the seat supporting the pivot is built in the form ready to be inserted into a corresponding hole as a push or drive fit, similarly to the outer race of a ball bearing (See Figs. 15 and 16). The seat block is inserted either rigidly into a hole, or by means of a spherical socket ring which, in turn, is a drive fit in the beam or other component part of the machine.

In Fig. 15a the bearing seat itself has a wide angled V-shaped notch; in Fig. 15b, a cylindrical hollow. In order to reduce wear an especially hard material (stone, Carboloy or the like) may be embedded in the block at the wearing point. In Fig. 16, 2 bearing blocks are inserted into the spherical socket, side by side, displaced by a certain angle with reference to one another. The spherical socket provides, of course, a self-aligning feature, enabling the bearing block to come into contact with the knife-edge with an even pressure. The intersection of the 2 surfaces gives a straight line for the knife-edge to rest upon. More than 2 bearing blocks can be arranged side by side in the same spherical socket and a large number of other modifications of the forms shown are possible.

On the basis of the foregoing, it seems to be open to doubt whether the manufacture of knife-edge bearings by the manufacturers of the weighing and testing machines should be persisted in, contrary to the modern trend of specialized manufacture. On the contrary, a well designed product made of the most suitable materials, based on thorough-going research, and built in standardized sizes under mass production methods by manufacturers who make this field their specialty, would most likely result in important economies in the manufacture and improved performance of the finished machine.

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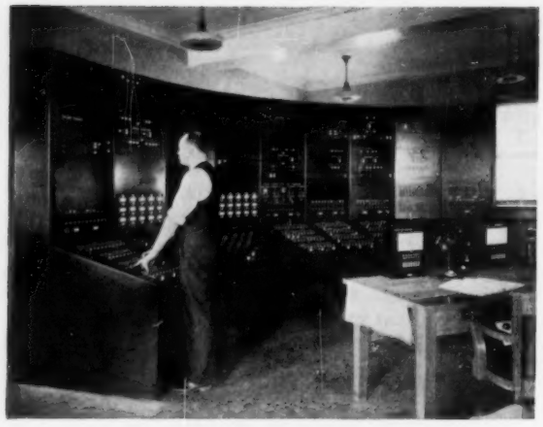
Instruction in *"Scientific Instruments and Their Use"* is offered by the Graduate School of the Department of Agriculture in a course comprising a series of lectures. The course is given at the Department Buildings in Washington, on Tuesdays and Thursdays, starting Feb. 2, 1932.

Lectures are by workers in the Department and in the Bureau of Standards. The course will deal with the design, principles, manipulation, and field of use of a selected number of most important instruments, especially those in which new technique has been developed. A list of the lectures is contained in a bulletin dated Sept. 14, 1931, by the Director of Scientific Work, U. S. Department of Agriculture, Washington, D. C.

As indication of the nature of the course, the following are titles of a few of the lectures included in it: Measurement of Humidity; Meteorological Instruments; Measuring and Recording Time Intervals; Oscillograph and Other Electrical Recording Methods; Photo-electric Cell, Grid-glow Tubes, Amplification; X-ray Equipment and Use; Hydrogen-ion Determinations; Methods and Apparatus for Gas Analysis, and Measurement of Low Pressures.



Miniature Controlling Equipment Concentrates Elaborate Control Assembly in Front of Operator, and Makes Controls Responsive to His Lightest Touch.

TRENDS IN ELEC
Controllin Equi

IN THE field of electric controlling equipment, developments have recently been coming thick and fast. But most of the changes have been so slight and gradual, that unless one views the whole field at once, it will not be evident that most of the developments have been along very few but very decided trends.

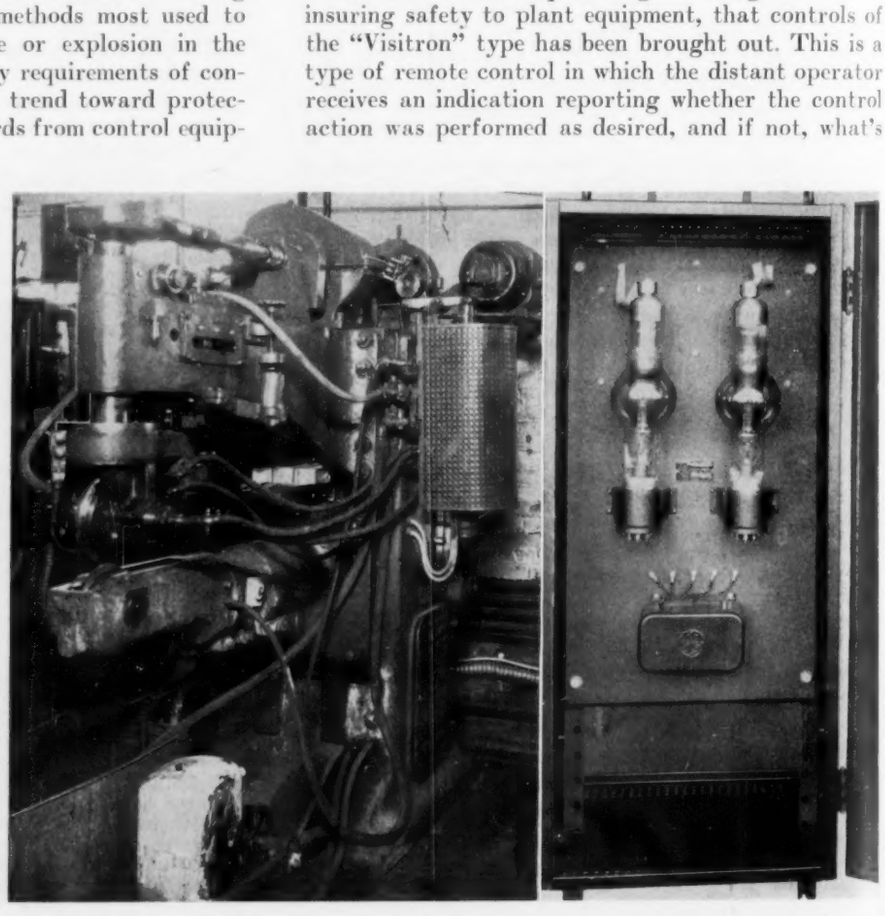
PROTECTION

Most prominent of these trends has been toward protection—protection for safety to the plant and safety to the operator. "Explosion proof," "Fire safe" have been very loudly proclaimed features of controllers, motor starters, electrical motors, even of switches and relays.

"Ironcladding" and complete enclosure of arcing or heating elements are the methods most used to obtain protection against fire or explosion in the plant. Originating in the safety requirements of control equipment for mines, this trend toward protection of the plant against hazards from control equipment has spread very rapidly to all branches of industry. This may be in part due to the growing consciousness that "Safety Pays." Much more responsible, though, is the widespread work of the Underwriters' Laboratories in setting up standards and specifications for safety, determining definitely what is safe and what is unsafe.

Safety for the operator and the plant machinery have also been emphasized features in electric controlling equipment recently brought out.—"Foolproof shielding" — "positive interlocking" — "automatic locking latch"—are some of the means employed to prevent accidental or mistaken operation and tampering.

So far have developments gone along the line of insuring safety to plant equipment, that controls of the "Visitron" type has been brought out. This is a type of remote control in which the distant operator receives an indication reporting whether the control action was performed as desired, and if not, what's



An Automatic Welding Machine and, at Right, the Simple Thyratron Equipment to Control the Heavy Welding Currents.

*Managing Editor.

IN ELECTRIC
in Equipment

By RICHARD RIMBACH*

Miniature Equipment and Cascading Arrangement for Controls Enables One Man to Direct Lighting of Entire Theatre from this "Organ-keyboard" Control Panel.

wrong. Supervision for safety need hardly be carried further to make it human.

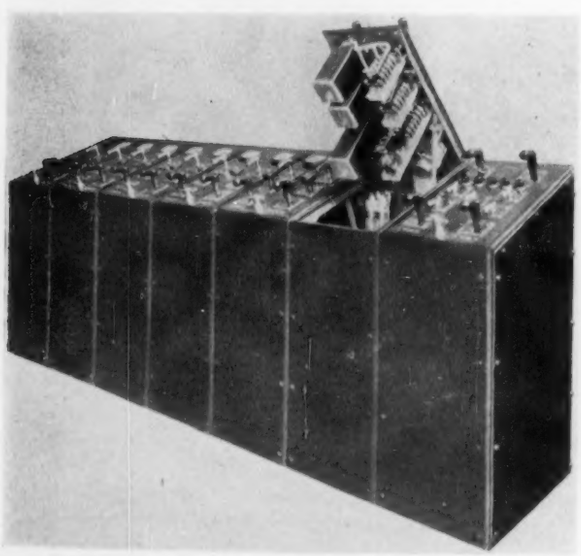
Protection of equipment against severe or abusive operating conditions is one trend along which development of electric controls has proceeded with a veritable surge. Motors particularly, not to mention controllers, starters, relays, have been "totally enclosed," "dust proofed," and made "resistant to acid and abrasive atmospheres."

CENTRALIZATION, FLEXIBILITY, CONVENIENCE

Every development that could be produced to put the controls right at the operator's elbow, and make them respond even to his lightest touch, seems to be coming right along. Particularly prominent in this direction is the trend toward concentrating all the controls at one location before an operator. Most progress in this line grew out of the recent rapid strides in telemetering and remote control.

The far greater concentration and flexibility of controls now possible has been attained largely through "miniature control" and "control cascading."

In "miniature control" the operator has concentrated on a board before him "miniature" controlling equipment, made up mostly of telephone apparatus. The operator actuates this miniature equipment, which in turn operates the secondary control equipment to perform the desired control function.



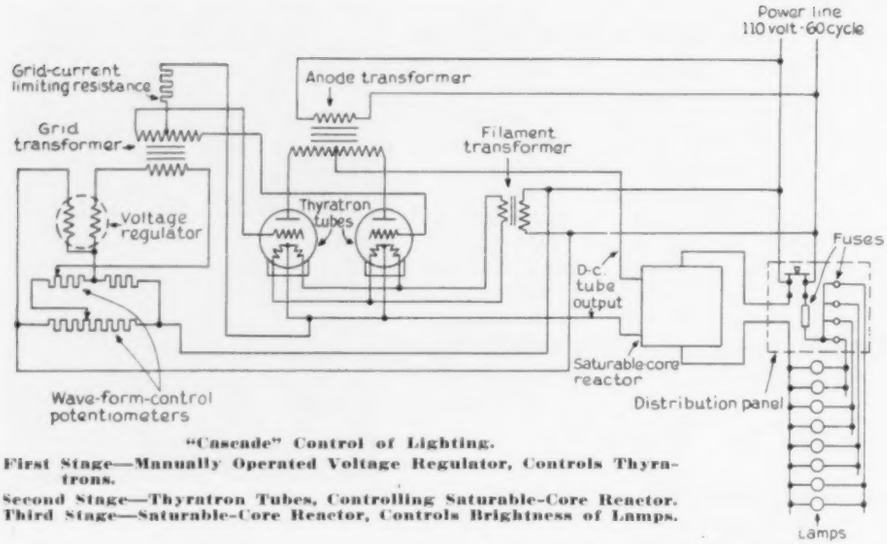
Controlling Equipment of Sectionalized "Units."

The notable features of miniature control are: Being of miniature size the controls can be concentrated on small boards to give the operator complete and handy supervision. Moreover, by using standard telephone parts, advantage is taken of having highly developed equipment available in large quantities, making for low initial cost, and ready replaceability. Also, ease of operation is greatly enhanced because it is so vastly easier for the operator to snap a telephone switch and let that operate a circuit breaker than to operate the breaker himself.

What remarkable development has already been attained in "miniature control" is well illustrated by the following control application:

In some rolling mills, such as reversing blooming mills and plate mills, the distance between the rolls, which determines the thickness of the metal passing through the rolls, must be adjusted after each pass. Usually this is accomplished by manual control (through magnetic equipment) of the "screwdown" motor which drives the screws that adjust the position of the top roll. An automatic screwdown control equipment was developed for this service and permits the roller to set up a schedule of passes on a master control board. Then as the operator rolls an ingot or plate, he simply presses a button or advances a master switch one notch after each pass, and the top roll quickly and automatically is moved to a position corresponding to the set-up on the master board for that particular pass.

"Control cascading" is another trend that has been going strong, thanks largely to the development of thyratron tubes. Particularly in industries and processes requiring huge amounts of power, the trend is toward using several stages of electrical control in cascade arrangement. The first stage is generally very light equipment, worked by an operator. This controls a second stage of more powerful equipment, which in turn operates the still more powerful units of the following stage—so on till the heavy equipment



"Cascade" Control of Lighting.
First Stage—Manually Operated Voltage Regulator, Controls Thyratrons.
Second Stage—Thyratron Tubes, Controlling Saturable-Core Reactor.
Third Stage—Saturable-Core Reactor, Controls Brightness of Lamps.

for controlling huge power flows is operated as directed by the light control apparatus of the first stage.

Thyratron tubes, being able to control huge power outputs under the direction of very feeble amounts of control power, greatly reduce the number of stages needed. So much so, that "cascaded" control is now finding application in cases where it would have been prohibitive without thyratrons.

For example, to make an electrical welder operate at high speeds, it is necessary to close and open at high speeds a heavy switch for large currents. This could be done by the operator opening and closing a small switch to operate a motor for opening and closing the large switch. This calls for two switching stages in cascade, with a motor to operate the larger one.

In place of this, a thyratron control recently developed uses a small switch for the operator. Opening or closing this small switch in the grid circuit of a thyratron turns on or off, through the thyratron, the full welding current. A second switch and motor are thus eliminated by a single thyratron, making practicable a control that would otherwise be cumbersome and costly.

In other cases thyratrons are providing a flexibility in cascaded control not anywhere near practicable before.

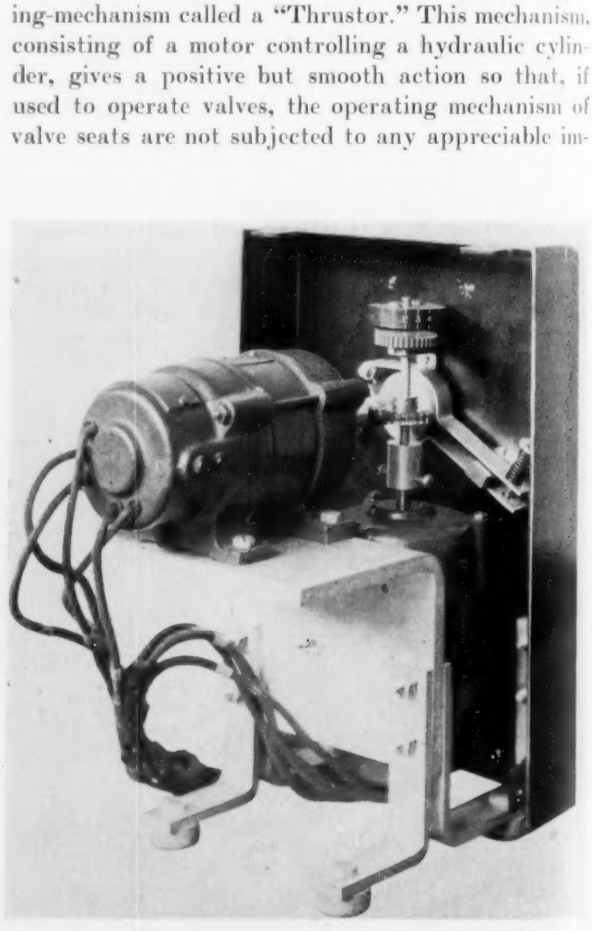
Theatre lighting, for example, has heretofore called for bulky backstage switchboards with equipment that was cumbersome to operate. Thyratron control eliminates the bulky switchboard and puts instant and accurate control of all lighting at the finger tips of a lighting-directing operator.

The scheme of control consists of a first stage for shifting the phase relationship between the grid and anode of the thyratron tubes. In this stage the manipulation is done with small knobs or switches at a comparatively small control desk or console. The thyratron tube output, so controlled, supplies varying amounts of direct current to a second control stage, comprising saturable-core reactors, whose a.c. circuits control the lights.

Towards providing increased convenience, secondary control equipment has recently been developing with a vigorous trend. Push-button control for motors, making it convenient to start or stop them from any push-button location, are increasingly prominent items of equipment. Also the practice of making motor starters self-controlled has become very general. All one has to do then in starting up a large motor is to throw a lever and let the starter do the rest, instead of going through several careful starting operations.

MOTORIZING

Noticeable in the general drift of developments in electric controlling equipment is a tendency to use electric motors for operations formerly done by hand or by special actuating apparatus. To illustrate, auxiliary motors are being incorporated in starters for large motors, which generally were operated by hand. Also, the smooth, powerful, and variable pull of a solenoid can now be provided by a motor-adapting-mechanism called a "Thrustor." This mechanism, consisting of a motor controlling a hydraulic cylinder, gives a positive but smooth action so that, if used to operate valves, the operating mechanism of valve seats are not subjected to any appreciable im-



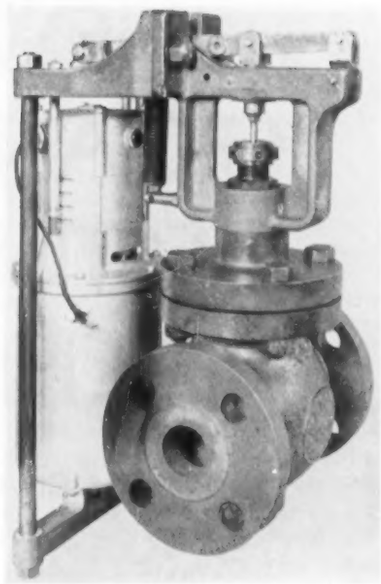
View of Mechanism for Remote Setting of Mill Rolls.

pact. No overload protection for the Thrustor is necessary since the motor on the Thrustor cannot be overloaded regardless of whether the valve opens completely or only part way. For this reason, the control is simplified.

By means of a rheostat, the speed of the single-phase a.c./d.c. motor can be varied so that the Thrustor working against a spring will give various degrees of opening. The opening will be only approximate but can be controlled by adjusting the rheostat to obtain the proper flow in the pipe line.

Even abrupt, very powerful, motions are being provided by means of a motor. The motor is arranged to coil up a powerful spring which, when released, gives the desired abrupt, vigorous motion. This mechanism has been applied to operation of circuit breakers, transformer load ratio changers, etc.

This motorising tendency came as the natural consequence to the standardised, quantity-production, electric motor. Manufactured on the mass production basis, the motor is a reliable, efficient, and inexpensive unit. In addition, standardization makes units readily replaceable. Therefore, though it generally runs at high speed, has a fairly small torque and rather constant characteristics, the electric motor finds ever increasing application as a power source even in equipment requiring special or irregular motions.



Motor Mechanism for Operating a Valve with Solenoid Motion.

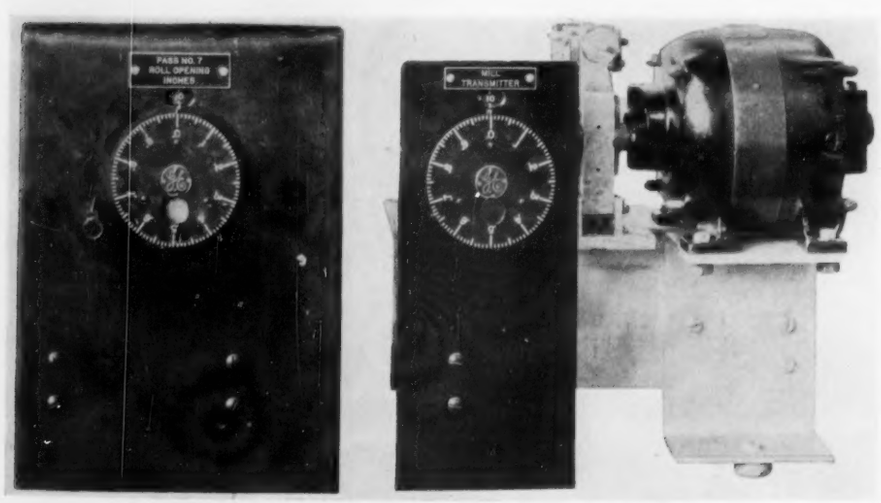
UNITS, INTERCHANGEABILITY

One prominent direction of development in electric controlling equipment is towards combining or sectioning the equipment into units. Motors are generally built integral with the apparatus they operate to constitute "units." Speed controls or starters are built right into some motors to comprise "units." The several elements of motor controllers and starters are being combined in one container making the whole controlling or starting equipment one "unit."

In the case of large assemblies of secondary control equipment particularly switch-boards, the individual items closely associated are combined in groups comprising "units," each unit forming a "section" of the whole control assembly.

For the unit complete in itself, the combination of all the elements together is mainly a manufacturing advantage, as much material and labor can be saved in mounting associated items all in the same housing. Operation is also in some cases improved by having the interdependent elements of equipment close together.

For the sectionalized units there is, in addition to the advantage in manufacture, the great maintenance feature of interchangeability. In a control board all of one unit, a fault in any small element may tie up all the apparatus associated with the whole board. If on the other hand, the control assembly is built up of unit switch-board sections, any one section can be readily removed for repair and inspection without disabling the rest of the control equipment assembly.



Mounting and Mechanism for Pre-Set Control of Rolling Mill.

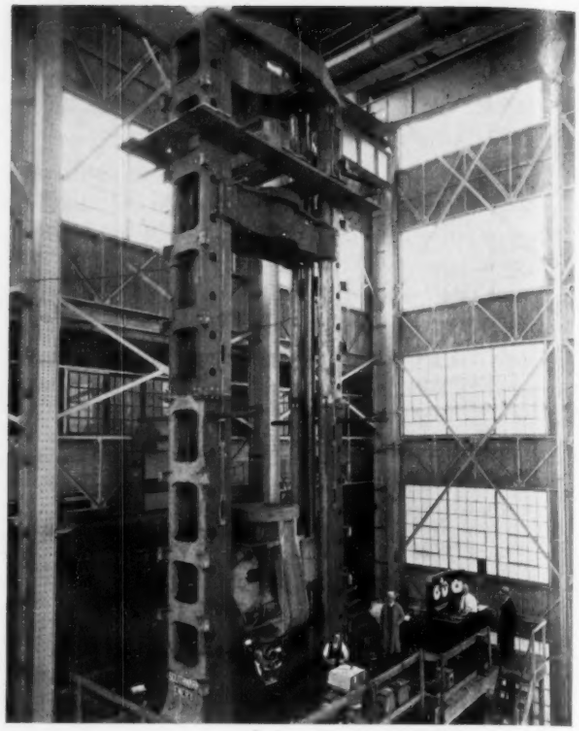
Explosion-Proof Motor Starter, Mechanism out of "Ironcladding" Container for Exposed View.

NEW GIGANTIC TESTING MACHINE

By RICHARD RIMBACH

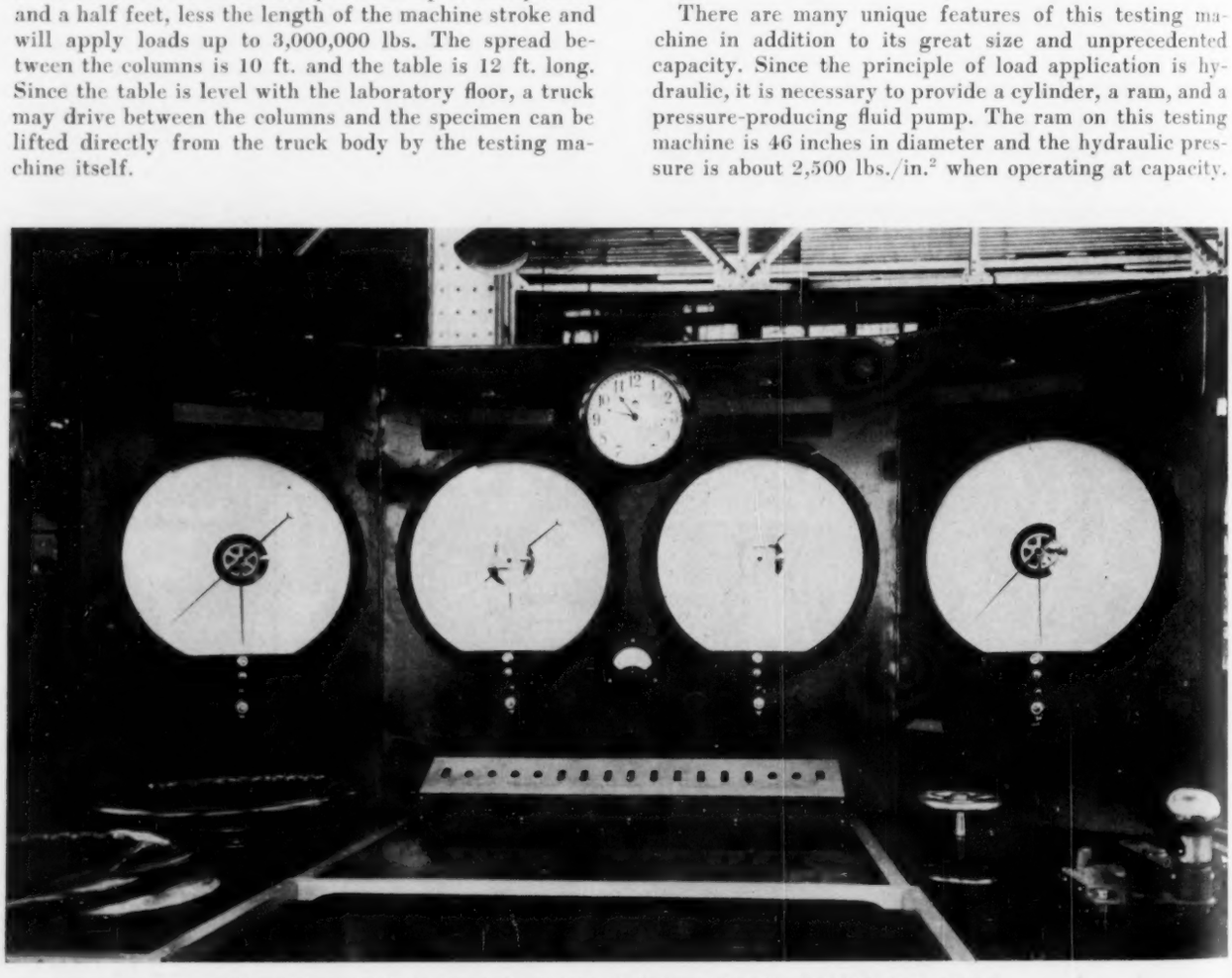
THERE has just been completed in and shipped from the shops of Baldwin-Southwark Corporation, Eddystone, Pennsylvania, to the University of California at Berkeley, California, the largest testing machine in the world. In point of dimension as well as capacity it is by far the largest.

It is able to test columns up to thirty-three and a half feet long in compression and up to 4,000,000 lbs. load. In tension it accommodates specimens up to thirty-three and a half feet, less the length of the machine stroke and will apply loads up to 3,000,000 lbs. The spread between the columns is 10 ft. and the table is 12 ft. long. Since the table is level with the laboratory floor, a truck may drive between the columns and the specimen can be lifted directly from the truck body by the testing machine itself.

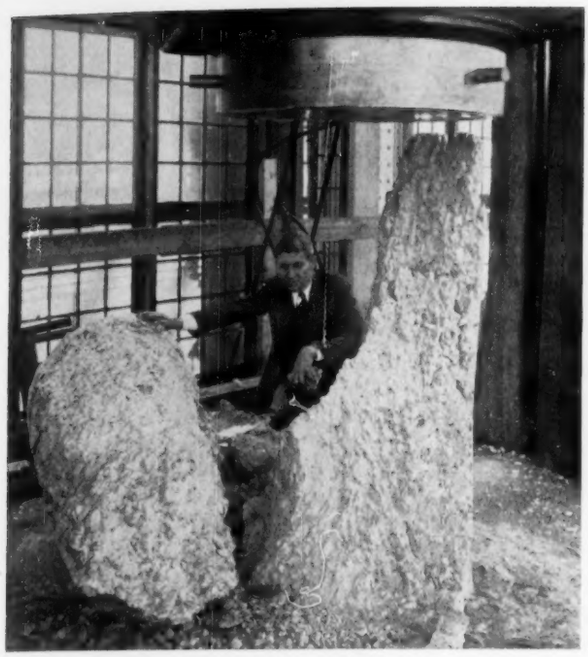


View of Machine Above the Floor.

There are many unique features of this testing machine in addition to its great size and unprecedented capacity. Since the principle of load application is hydraulic, it is necessary to provide a cylinder, a ram, and a pressure-producing fluid pump. The ram on this testing machine is 46 inches in diameter and the hydraulic pressure is about 2,500 lbs./in.^{2} when operating at capacity.



The Instrument Board and Control Desk from which the Machine is Operated.



Test of a 32-inch Diameter Concrete Cylinder.

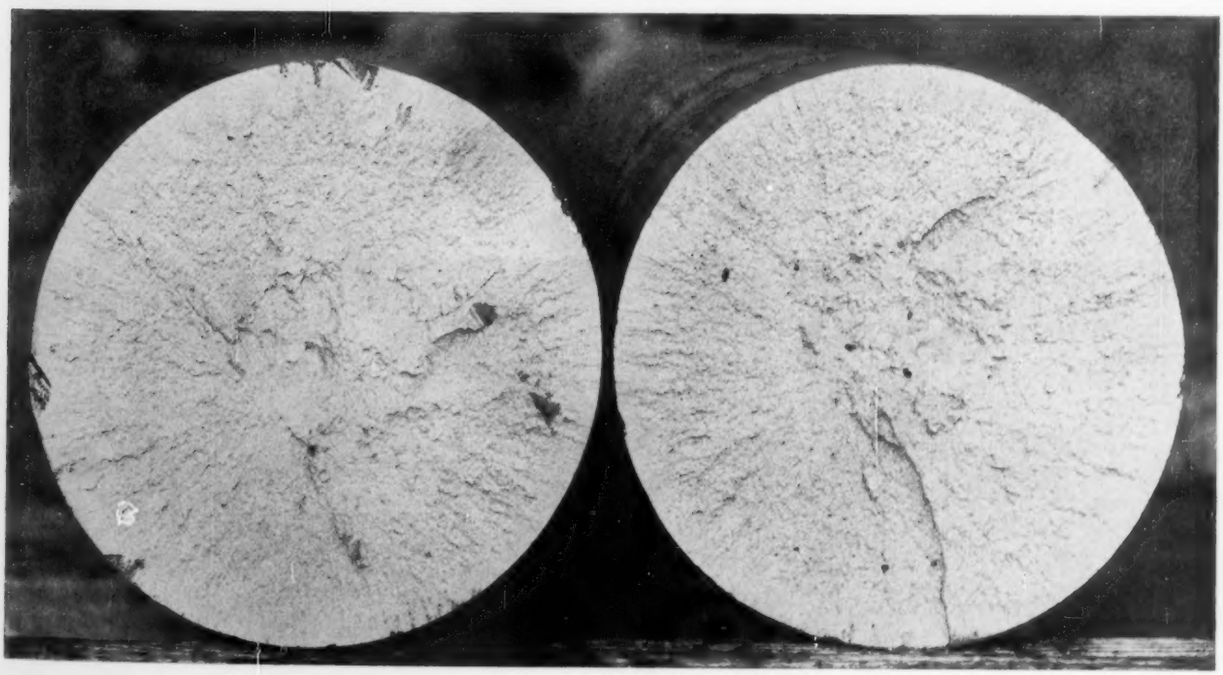
The table of the testing machine is stationary, being secured directly to the foundation. The ram is fastened to this table. The cylinder, therefore, is the movable element and to it are fastened by lug extensions two vanadium steel screws of 12 inches diameter, 56 feet 8 inches long, threaded with double 1/3 square thread per inch. By means of long bronze nuts which are embedded in the lower cross-head (which carries also the weighing system and, in a yoke, the lower grips for tension testing) the loads are transmitted from the screws to the cross-head. The purpose of the threads, however, is not to produce the load as has been the practice in some types of testing machines. During loading there is no movement of nut and screw relative to one another. The function of the screw and nut is to raise or lower the lower cross-head so that the space available for testing may be changed to accommodate the specimen to be tested.

Compression tests are carried out between the lower cross-head and the table while tension tests are made between the upper cross-head and the yoke around lower cross-head. The total stroke of the lower cross-head (load stroke and not movement on the screws) is 48 inches—ample for the extension of practically any tension specimen likely to be tested in this machine. The total adjustment for change of specimen length is 33½ feet. This latter change is effected by rotation of the screws (while unloaded except for weights of parts) by means of a geared motor controlled from a control board which will be located at some distance from the machine in a glass enclosed room. Communication between the operator in the control room and the operator at the machine is carried on by telephone. In addition loud speakers may be brought into action so that a group may be informed of the progress and technique of the test.

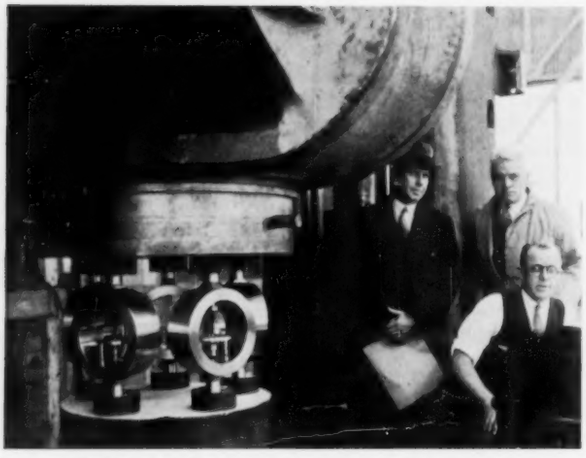
The materials of construction are: high grade steel castings, alloy steel forged parts, and high grade bronzes. The rams are of close grained cast iron and are ground to a final finished diameter. The weight of the main ram (46 inches diameter) is about 28,000 lbs. and that of the cast steel cylinder is 40,000 lbs. The grips for tension testing are nickel chromium steel, heat treated, and machine cut. They weigh more than 3,000 lbs. and occupy recesses in the cast steel cross-heads which are about one foot by two feet. They are handled by air cylinders, being too heavy for manual manipulation.

The cast steel table to which the main cylinder ram is fixed and on which the cast steel columns rest is 17 feet 3 inches x 6 feet 6 inches in plan and weighs nearly 50,000 lbs. Its depth is 35 inches.

This machine stands 46 feet 9 inches above the floor line and the foundations extend to about 25 feet below.



Fracture of an 8-inch Diameter Low Carbon Steel Specimen.



Photograph Taken During the Calibration of the Machine.

The depth of the pit is 19 feet. Total weight on the foundation is about 475,000 lbs.

In both compression and tension testing the lower cross-head moves downwards. In order that these heavy weights—about 200,000 lbs. may be returned to position preparatory for a new test, it is necessary to provide two 13 inch diameter pull-back cylinders which are supplied with pressure from the same source as that for the main cylinder and ram. These pull-back cylinders have another very important function to perform. In the failure of specimens either in tension or in compression there is an enormous store of energy released in a very small fraction of a second. These cylinders and rams together with four nests of heavy springs absorb this "shot" of free energy and damp it out without damage to the structure, acting like gun recoil chambers.

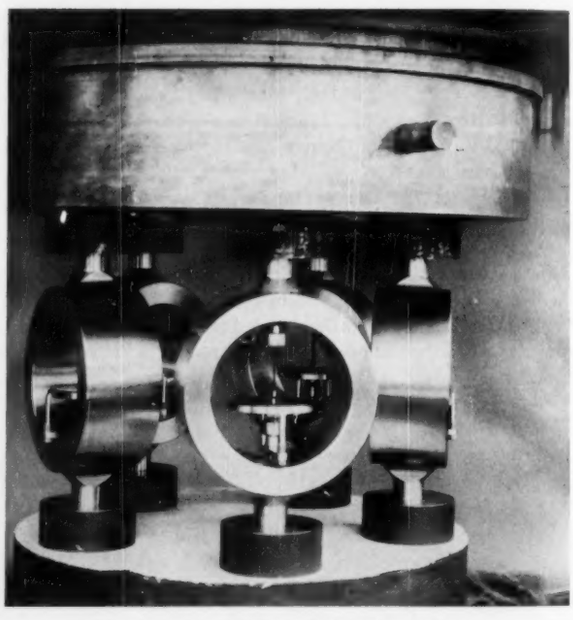
Because the height of this machine above the floor is equivalent to more than that of the third floor of an average building, provision has been made for the application of an elevator. This will permit the presence of assistants at any level for extensometer readings, for examinations of the specimens, or for inspection of the grips.

The pressure producing mechanism is a multiple rotating cylinder pump driven by a 20 h.p. motor. The motor for moving the lower cross-head is 50 h.p. and head speed is 24 in./min. All controls are collected at a welded steel power plant type instrument board with a ledge for a desk having a sheet Bakelite covering.

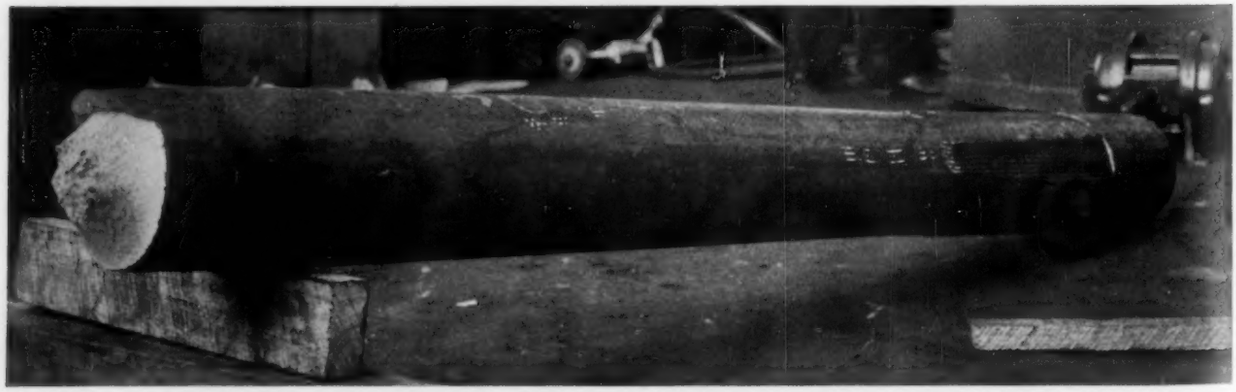
The heart of the weighing system is the Emery support or hydraulic capsule. The pressure in the main ram is not at all measured. In the path of the forces coming from the main ram to the specimen is the hydraulic capsule. This is a very heavy inelastic cylinder having a loose fitting piston the end of which is covered by a diaphragm. The movement of this ram is of the order of a few thousandths of an inch at the most and the oil (with which the capsule is filled) displaced by this micrometer motion causes a change of shape of the elastic tubes (with which the capsule is connected) in the indicating instruments of which there are four on the instrument board. The ranges of these indicating instruments are: 0 to 4,000,000 lbs.; 0 to 2,000,000 lbs.; 0 to 525,000 lbs. and 0 to 200,000 lbs. The care with which calibration is carried out can only be appreciated by witnessing the process. The calibration of this machine required the services of three men for one week.

This calibration was effected by the use of Morehouse proving rings which were calibrated at the Bureau of Standards in Washington, in a dead weight machine in which weights up to 100,000 lbs. may be applied by increments.

(Continued on Page A21)



Close-up View of Calibrating Rings.



Fracture of Another 8-inch Diameter Specimen Showing Cup and Cone Fracture as well as Bulging of the Specimen at the Grips.

Flow Measurement and Control*

By M. F. BEHAR†

CHAPTER XXV

HEAD METERS‡

An examination of Table VI-2 shows that there is only one class of meters of which all types are applicable without limitation to the measurement of all fluids in pipes. This is the class known as head meters, which comprises several well-known types. The table simply states that "all types" are free from "limitations." We might proceed with a supplementary table confined only to the head meters. The nature of this subject, however, requires not a table but an analysis of types and a very necessary practical discussion of factors that must be considered in the use of head meters.

The following symbols in customary use, adopted in the report of the A.S.M.E. Fluid Meter Committee, are accordingly adopted here:

	Symbol Description	Unit
A	area of section	sq. ft.
a	radius of section	ft.
B	turbulence factor	ratio
b	width of weir	ft.
C	coefficient of discharge	ratio
c	radius of curvature	ft.
c_p	specific heat at constant pressure	
c_v	specific heat at constant volume	
D	diameter of section	ft.
d	diameter of section	in.
E	intrinsic energy per unit weight	ft-lb. per lb.
e	internal energy per unit mass	
F	loss due to dissipated energy	ft-lb. per lb. of flow
f	function	
g	gravitational acceleration	32.174 ft. per sec. per sec.
H	$E+p_v$ (total energy)	ft-lb.
H_t	heat energy per hour	
h	effective differential head	ft.
h_v	$\frac{s^2}{2g}$ (velocity head)	ft. of fluid at density of measurement
I	moment of inertia	
K	kinetic energy per unit weight	ft-lb. per lb.
k	ratio $\frac{c_p}{c_v}$	
l	length	ft.
M	$\frac{A}{\sqrt{R^4-1}}$	(meter constant)
m	mass flow	
$\mathcal{N}$	non-uniformity factor	
n	number of contractions	
P	pressure	lb. per sq. in.
p	pressure	lb. per sq. ft.
$\mathcal{Q}$	volume rate of flow	cu. ft. per hr.
R	$\frac{D_1}{D_2}=\frac{d_1}{d_2}$	ratio of entrance to throat diameter
r	$\frac{D_2}{D_1}=\frac{d_2}{d_1}=\frac{1}{R}$	ratio of throat to entrance diameter
S	mean speed	ft. per sec.
s	speed	ft. per sec.
T	absolute temperature	
t	time interval	
U	kinetic energy per unit of mass	
u	$\frac{p_2}{p_1}$	ratio < 1
V	volume rate of flow	cu. ft. per sec.
v	specific volume	cu. ft. per lb.
W	weight of flow	lb. per hr.
w	weight of flow	lb. per sec.
X	$F+(\mathcal{N}_2^2-\mathcal{N}_1^2)+(B_2^2-B_1^2)$	
x	ratio of suction to impact	
Y	correction factor for compressibility of gases	
y	$\frac{\mu}{\gamma}$	kinematic viscosity
Z	height from center of gravity of flow to a fixed base level	ft.
	density of the fluid	lb. per cu. ft.
ω	angular speed	radians
μ	absolute viscosity of fluid	
ρ	$\frac{pv}{T}$	
τ	ratio of circumferential to axial speed	

*Part VI of *The Manual of Instrumentation.*
†Engineering Editor, *Instruments.*
‡The author is indebted to G. P. Crist of the Republic Flow Meters Company for much of the theoretical portions of this chapter, especially Sections 4 to 6 incl. The standard source used by the author is the A.S.M.E. Fluid Meter Committee's report. Other references are given under "Bibliography."

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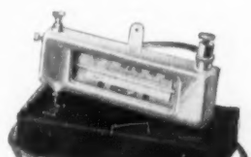

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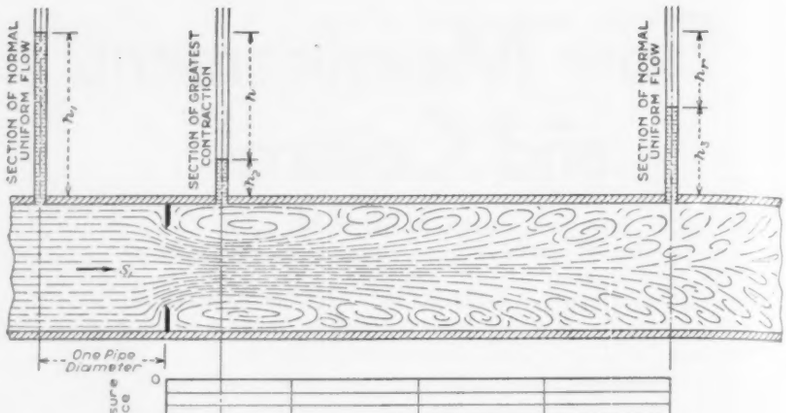

Fig. 25-1

The symbols without subscripts are general; where used to apply to specific conditions suitable subscripts are used, numbering, in general, from the upstream to the downstream section. For instance, the upstream section of a venturi would be designated by D_1, A_1, the corresponding conditions p_1, v_1, γ_1, etc. The throat section would then be designated D_2, A_2, and the conditions p_2, v_2, γ_2. Another case, h_w, is a special reduction of h, translated to inches to water at 62.425 density; h_m would be inches of mercury in air; and h_{wm}, inches of mercury under water. The A.S.M.E. Committee uses mnemonic subscripts for fixed reductions and number subscripts for sections of the stream.

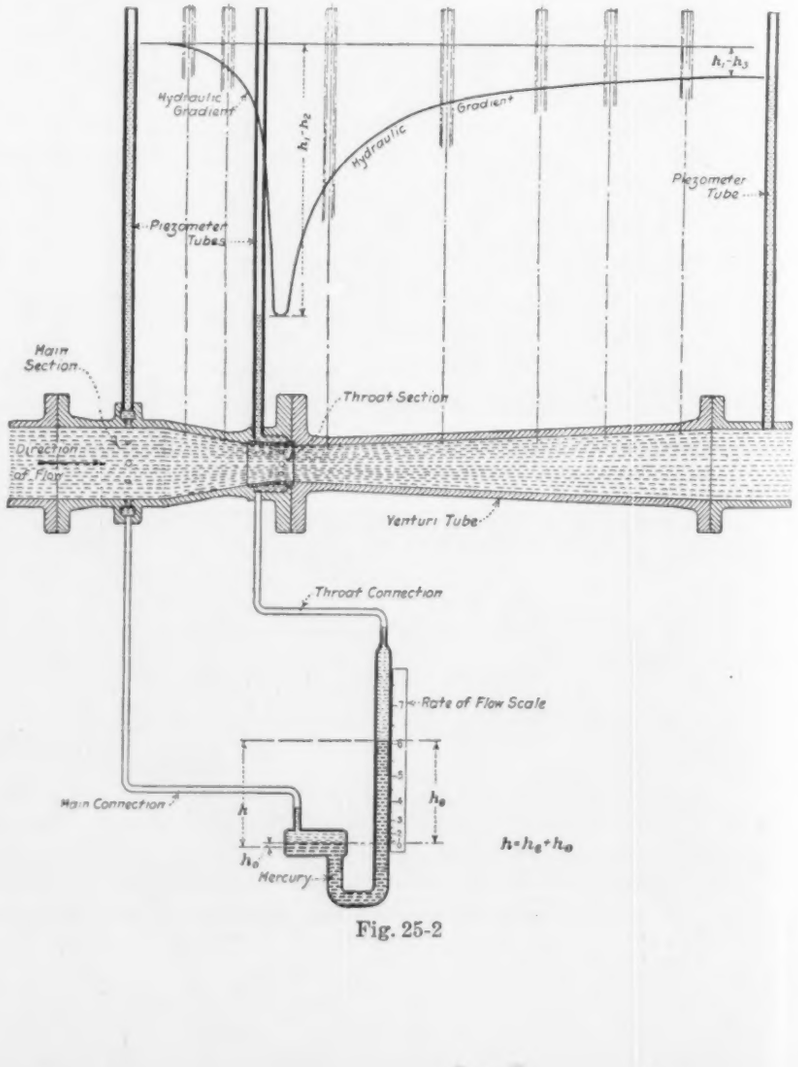

Fig. 25-2

1. Types of Primary Elements

The first consideration is the selection of the type of primary element to be placed in the pipe line, which determines the "type" of the meter. Each type has advantages and disadvantages, of which a brief summary follows:

Orifice Plate.—Advantages: Low cost; ease of installation, without change of piping; readily changed for change of capacity; accuracy at all flows; and thin edge, not subject to change in diameter.

Disadvantage: Greater pressure loss for given differential.

Fig. 25-1** represents fluid flow through an orifice plate of the most usual form, a thin plate with concentric orifice having sharp edges. The section of greatest contraction, where velocity is highest and static pressure lowest, is known as the *vena contracta.*

Venturi Tube.—Advantage: Low pressure loss for given differential.

Disadvantages: Comparatively high cost; difficulty of installation, requires piping change; difficulty of changing capacity; variation of coefficient at low velocities; and throat diameter subject to change.

Fig. 25-2 shows a typical section of a Venturi tube primary element and a conventionally represented secondary element. The "main section" and "throat section" are usually machined so that their diameters may be determined exactly. Piezometer rings are illustrated, being the usual forms of pressure holes. In this connection see Chap. XVI, Sec. 7.

Flow Nozzle.—Advantages: Moderate cost; and useful for moderate differentials at high velocities.

Disadvantages: Difficulty of installation, may require piping change; difficulty of changing capacity; variation of coefficient at low velocities; and greater pressure loss for given differential.

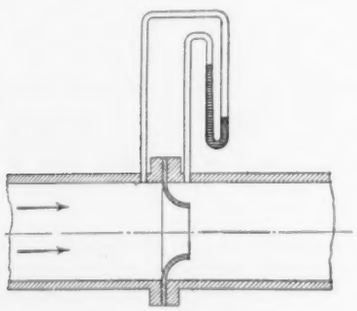

Fig. 25-3

Fig. 25-3 is a conventional representation of a spun type of flow nozzle and secondary element. Note the location of the downstream tap opposite the straight part of the jet, in the plane of the end of the nozzle throat: at this place the pressure has been found to be almost exactly the static pressure in the jet as it issues from the throat with maximum speed and parallel flow. The upstream connection, usually, is not as shown in the diagram but at a distance of about one diameter ahead of the entrance of the nozzle.

Pitot Tube.—Advantages: Low cost; ease of installation without change of piping; no pressure loss; and useful for high velocities.

Disadvantages: Long straight pipe required; limited accuracy; fixed differential for given conditions of pipe size and flow; and mechanical difficulties due to stoppage of the tubes.

There being no "standard" form of Pitot tube, none is illustrated at this point. Various forms will be shown and discussed under descriptions of head meters on the market. The theory was outlined in Chap. XVI, Sec. 9.

2. Location of Primary Element

The requirement for accurate results in every case is a straight run of pipe before the primary element which insures straight line flow. The length of straight pipe before the orifice, venturi, or nozzle, is a function of the ratio of the "throat" (d_2) to the pipe diameter (d_1). An approximate formula for the length of pipe is $L = 15$ to $20\ (d_2^2/d_1^2)$ where $L = nd_1 =$ number of pipe diameters before the primary element. For the pitot tube, the length of straight pipe should be at least 20 pipe diameters. When the proper length of straight pipe is not available the same result is obtained by the use of straightening vanes. The length of pipe after the primary element should be one or more pipe diameters. With the venturi tube, this is applied by the diverging cone.

Other considerations affecting the installation of the primary element are (1) the pipe section before and after the primary element must be kept free from any deposit which would reduce the pipe diameter; (2) the location of the secondary element must be considered in planning the installation, to avoid extremely long piping connections, extreme heat, freezing, or other deleterious conditions.

**From A.S.M.E. Fluid Meter Report, as are other diagrams in this part unless otherwise credited.

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CHEMIST: Graduate Hunter College 1918. Spent twelve years working out various chemical processes in the laboratory and demonstrating them from a practical standpoint in paper mills. Work in the laboratory has included water analyses, some bacteriological work, fibre examination, and testing of various material. J-22.

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Theory of Thermal Measuring Devices for Electricity. (Theorie der thermischen Messgeraete der Elektrotechnik. Grundlagen zu ihrer Berechnung.) *By Dr. — Ing. Johannes Fischer.* Ferdinand Enke Verlag, Stuttgart, 1931. Paper 6½x10 inches, 147 pages, Price 13 RM.

It was a very meritorious undertaking to treat theoretically the thermal instruments, a class which in recent days becomes more and more important because of the needs for sensitivity and accuracy in the measurement of small energies, particularly in the large field of radio technique. But the theoretical treatment does not exhaust the volume. The practical value of connections and methods for practical use are never lost sight of. The first chapter gives the definition, the measures for sensitivity, and the various kinds of thermal instruments (i. e. hot-wire instrument, hot-wire air thermometer, bolometers, and thermo-couples). The second chapter deals generally with the theory of these instruments and their heat transference. In the following chapters the different types are each treated exhaustively. The arrangement is very lucid, each chapter develops first the formulas for the respective type of instrument treated in the chapter, then examples are given, and the relation between sensitivity and dimensions of the instrument is discussed. In this way the thermo-couple, bolometer, hot-wire instrument and air thermometer, thermo-cross and Peltier effect and thermic product meters, as well as thermo-electric wattmeters, are fully discussed. Some experimental data and an extensive literature reference supplement the little volume which is readably printed and gives tersely the information wanted. If a wish might be expressed it would be, that in a new edition an index might be added in front of the book for all reference designations; although the same letters have almost always the same meaning, it would be easier to refer to such index instead of having to look to other chapters for an eventual necessary reference.

M. Hartenheim.

Scientific Applications of Photography. (Handbuch der Wissenschaftlichen und Angewandeten Photographie. Band VI. Wissenschaftlichen Anwendungen der Photographie.) Edited by M. von Rohr (succeeding Alfred Hay, deceased). Julius Springer, Vienna, 1931. Paper, 7x10 inches, 289 pages, 265 figures, and 2 plates.

The sixth volume of this comprehensive treatise (see INSTRUMENTS, June 1930; Jan., June, 1931;) has made its appearance, at least the first part. Devoted to the scientific applications of photography, the publisher has made a division into ordinary and microphotography, and a glance into the index justifies this entirely. This first part is devoted to spectrophotography, astrophotography, and projecting technique, and makes extremely interesting and instructive reading not only for the expert in this field, but even more so for the amateur. This does not mean that the book is written only for the latter. By no means; the same masterly, clear, exposition that one is used to from the volumes already published is found here again, and leaves hardly any field or item not treated. The chapters on stereophotography reveal a field not imagined to have such extent. Starting from the physiological basis of vision and of the construction of the eye, all the different systems of creating stereoscopic pictures and their applications, with proper consideration of psychological factors, are thoroughly discussed and explained by numerous illustrations. These are often selected with particular artistic taste, as those on pages 67 and 134, among others. The examples shown in the chapter on practical application seem indeed to open a wide field for demonstrations, especially for teaching purposes.

Historical remarks and international agreements introduce the reader into the section of astrophotography for which, at first, the spherical trigonometrical fundamentals are treated, and methods and instruments explained. With the discussion of the errors of photographs and their evaluation, the aberration of a light ray near the gravitational field of the sun according to Einstein's theory is very skillfully connected, and is illustrated by a photograph. The various astrophotometric methods; spectral classes; the important part of the spectroscope in this field; determination of velocities by it, as well as photography of planets and of the moon are all treated as fully as can be desired; and always the best available photographs, especially of nebulae, seem to have been selected for illustration. But here again it must be expressed, as in the review of a previously published volume, that it is a pity many of the illustrations have not been made in colors, for then the work would have been an outstanding one.

The concluding section is devoted to projecting, again preceded by a historical review. The methods of episcopic and diascopic projection; sources of light; screens; diapositive, stereoscopic projection; panoramas; enlarging apparatus;—all are fully treated with the simplest mathematics, making it possible even for amateurs to make good use of this book. Each section is followed by an extensive reference list of literature. Printing and illustrations are clear and make reading easy and pleasant.

M. Hartenheim.

Das Katathermometer als Anemometer. By O. M. Faber. Number 6 of Messen und Prufen, Einzeldarstellungen aus dem Gebiete des Messungs-und Materialprufungswesens. Edited by L. Litinsky. Verlag Wilhelm Knapp, Halle (Saale) 1931. Paper 5½x8¼ in., 85 pages; 34 figures. Price 4.80 RM.

This little monograph is devoted to the measurement of very small velocities of flowing gases; a subject which today has considerable importance in the mining industry for the determination of ventilation in shafts. At first it is shown that the usual methods with orifice instruments and anemometers can not be employed with sufficient accuracy if the velocity is slower than 1 m/sec (3 ft/sec). The tests made with the so-called Katathermometer appear to make this instrument eminently useful for this kind of measurements.

(Continued on Page 51)

In measuring liquids, the primary element should be so located that the pipe section will be kept free from air, which reduces the effective pipe diameter. For sewage or liquids carrying suspended matter, the pipe section at the primary element must be kept clear by washing or other means. In measuring gases, the accumulation of water at the primary element must be prevented. This may be accomplished by locating it in a vertical pipe or in a horizontal pipe drained at both ends, or by installing suitable drips at the primary element. For dirty gases, the pipe sections and primary element must be kept clear by washing or blowing out the pipe section regularly. For steam, the pipe section must be kept free from water by using a pipe drained at both ends or by installing traps. A vertical pipe will be free from water but presents difficulties in the connections to the secondary element, which difficulties make a horizontal pipe more desirable.

Critical Speed—Two distinct modes of flow are recognized, namely, stream line or parallel and turbulent. In parallel flow the filaments move in definite paths and the resistance to flow is due to shear of adjacent layers and is proportional to the viscosity and to the velocity. In turbulent flow the motion at a given point varies irregularly from moment to moment and the resistance is approximately proportional to the square of the velocity, depending very little on the viscosity of the fluid. At low speeds the flow of a fluid in a straight conduit is usually parallel. As the speed is increased the flow becomes turbulent. For every diameter of conduit, every condition of conduit wall, and every fluid, there is a critical speed at which parallel flow becomes turbulent flow. While Reynolds and others have thoroughly investigated turbulent flow, the formulas used in practical head metering apply mostly to parallel flow and industrial installations of head meters should for best results be made in accordance with instructions relating to provisions against exceeding the critical speed.

3. Connecting Piping

The secondary element of the head meters must include a differential pressure gage—some form of manometer or U-tube using mercury or (for gases) oil or water. This secondary element is connected to the pressure taps at the primary element with steel or copper tubing or steel or brass pipe. (For detailed discussion of pressure taps and connecting lines see Chap. XVI, Sections 8 and 9.*)

For steam and water, the pressure taps are usually located on the side of the pipe (with venturi tubes a piezeometer ring is used) and the secondary element placed below the primary element. However, by proper arrangement of the piping, the secondary element may be placed above the primary. With a steam meter, it is essential that the same water head be maintained in the connecting pipe on both sides of the manometer. This means that for vertical pipes a riser must be used from the lower tap to the level of the upper tap. This leaves a possible air trap in the piping and a source of error due to water hanging up in the vertical riser. It is also customary with steam meters to use some form of condenser and reservoir at the pressure taps to maintain the water level in the connecting pipes.

For air and gases, the pressure taps may be located in the top or sides, preferably the former, and the secondary element may be placed above or below the pipe line. The connecting piping must be arranged to prevent water traps.

4. Relation of Rate of Flow to Differential Pressure

Just as temperature is obtained from the emf of a thermocouple, so, in the case of head meters, rate of flow is obtained from the differential head produced by the primary element. Flow formulae for head meters have in recent years been simplified. Ambiguous or debatable symbols, values and terms, as well as proposed methods of attaining "fourth-decimal accuracy," continue as subjects of serious discussions which advance the state of the art, but need no space in a practical manual. In the calculation of the rate of flow from manometer readings, the same general equation may be used for the orifice, the venturi and the flow nozzle (with suitable discharge coefficients for each type). It is unfortunate that no standard for defining and evaluating the discharge coefficients is in general use. Nevertheless, it always is possible to convert the value from one basis to another.

*These appeared as Sections 9 and 10 of Chapter X of Béhar's original handbook and were published in *Instruments*, December 1930, pages 765 to 774.

The discharge coefficient may be given as a function of the ratios d_2/d_1, d_2^2/d_1^2 or d_1/d_2; it may be made to include or to omit the velocity-of-approach factor; and it may be expressed as related to the pipe diameter or to the throat diameter. These various relations may be expressed as follows:

$$V = C_1 \frac{A_1}{\sqrt{1 - d_2^2/d_1^2}} \sqrt{2gh} \quad (1)$$

$$V = C_2 \frac{A_2}{\sqrt{1 - d_2^2/d_1^2}} \sqrt{2gh} \quad (2)$$

$$V = C_3 A_1 \sqrt{2gh} \quad (3)$$

$$V = C_4 A_2 \sqrt{2gh} \quad (4)$$

where V = rate of flow, cu. ft./sec.,
d_1 = pipe diameter, A_1 = area, square feet,
d_2 = orifice, venturi or nozzle diameter, A_2 = area, square feet,
g = acceleration of gravity,
h = differential pressure in feet of head of the flowing fluid.

Using $g = 32.16$ and 1 cu. ft. water = 62.42 lbs., the above equations may be simplified to

$$W = 359.16\ C_1 d_1^2 \sqrt{H\gamma} / \sqrt{1 - d_2^2/d_1^2} \quad (1a)$$

$$W = 359.16\ C_2 d_2^2 \sqrt{H\gamma} / \sqrt{1 - d_2^2/d_1^2} \quad (2a)$$

$$W = 359.16\ C_3' d_1^2 \sqrt{H\gamma} \quad (3a)$$

$$W = 359.16\ C_4 d_2^2 \quad (4a)$$

where W = rate of flow, pounds per hour,
d = diameter in inches,
H = differential pressure inches of water,
γ = density of flowing fluid lbs./cu. ft.

As defined above, $C_1 = C_2 d_2^2/d_1^2$, $C_1 d_1^2 = C_2 d_2^2$,

$$\frac{C_2}{\sqrt{1 - d_1^2/d_2^2}} = C_4 \text{ and } \frac{C_1}{\sqrt{1 - d_1^2/d_2^2}} = C_3$$

The term $1/\sqrt{1 - d_2^2/d_1^2}$ is the *velocity of approach factor* which increases from 1 to ∞ as the ratio d_2^2/d_1^2 increases from 0 to 1. The values of C_2 as defined above are, for the venturi and flow nozzle, 0.95 to 1, for the orifice 0.60 to 0.63. The latter values (for thin-plate orifices in pipes) are shown in Fig. 25-4 for water (curves A and A[1])and for water (curves B, C and D, all due to Spitzglass). Note the close agreement.

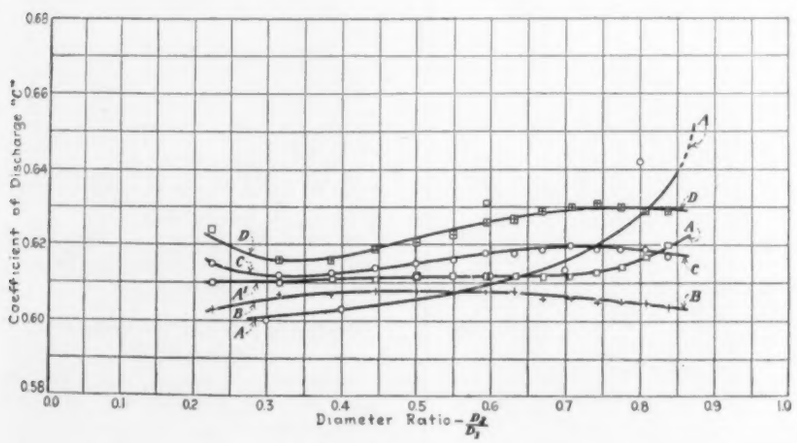

Fig. 25-4

The remarks on orifice coefficients are for orifices with the high-pressure tap at one pipe diameter from the orifice and the low-pressure tap at the vena contracta. The coefficients for other tap locations will vary from those given here. The vena contracta location may be taken as $2\frac{1}{2}$ times the "rim" of the orifice, *i.e.*, $\frac{1}{4}(d_1 - d_2)$.

The Katathermometer belongs to the class of cooling meters; that is to say, the instrument is heated in warm water and then the heat loss is measured during a certain temperature interval, in this case by cooling from 38° to 35°C. It is, so to speak, an inverted calorimeter in function. The heat loss is expressed in mg. cal. per cm² surface per 1°C.

Now it is strange that although the theory of the measurements with this device is clearly and exhaustively set forth, not a syllable is said of the construction of the instrument, nor is an illustration of it given. Besides mentioning that it was invented by an Englishman named Hill and several references where it has been employed formerly, one should, and is fairly entitled to expect, a description of the instrument itself and its operation in a paper devoted to its applications. It is clear that with the cooling constants of the measuring device for stationary air and for moving air known, it is possible to calculate, from the cooling action, the velocity of the surrounding medium. This is convincingly shown, as are also the theory for the development of handy formulas; the test arrangements for the experimental determination in wind tunnels of velocity as function of temperature, cooling time, and other air conditions; the accuracy of the device and how to carry out measurements with the Katathermometer, as well as how to calibrate it—this is all lucidly developed. Moreover, it is proved that this instrument is the only one reliable enough to measure small flow velocities. So, having devoted 80 pages to these items, it would have been fair to add a few, or even to use those twelve now filled with a reproduction of the details of the tests, for a clear explanation of what a Katathermometer is, and how it is operated.

The name Katathermometer might perhaps better be replaced by "heat loss meter' which, although just as clumsy a name, conveys a clearer idea of its usefulness.—Max Hartenheim.

Foundation and Methods of Chemical Analysis by the Emission Spectrum. Authorized translation of "Die Chemische Emissionsspektralanalyse." By Dr. Walther Gerlock and Dr. Eugene Schweitzer. Adam Hilger, Limited, London, 1931. Cloth, 6¼x10 inches, 123 pages.

This attractively printed booklet presents the authors' reasons why spectrographic analysis should come into wider use and in considerable detail the methods used in their laboratory as well as other current technique. They prefer spark-spectra to arc and claim the 4 following advantages for spectrographic analysis over ordinary chemical analysis—"Expedition, the possibility of analysis of minute quantities of material, the entire preservation of the available material, and the facility of ascertaining the distribution of an element in a given substance."

The subject matter is divided into seven chapters including theoretical aspects, discussion of equipment, qualitative and quantitative analysis, refinements by photometric measurements and special problems. The book is entirely free from any advertising for the publishers and is well worth while for the prospective user of spectrographic equipment as well as those directing analytical work.—C. P. Larrabee.

Textiles on Test. By J. Guilfoyle Williams. Chapman & Hall, Ltd., London, 1931. Cloth, 7½x5 in., 194 pages, 63 figs. Price 8s.

The title is well chosen, for it is a good compendium of tests to which fabrics should comply, of standards to which they should measure up: the tests and standards required from the viewpoint of the retail distributor wanting to succeed, who realizes that in giving his customers the utmost that their money can buy, he is building up his own house upon solid foundations.

The foreword by Gordon Selfridge reviews the book quite well, with this exception, however, that one can not expect the customer to study a book

(Continued on Page 52)

of this nature, or to test the merchandise he buys from a store in which he places his confidence. Nor is the book sufficiently specific in its details to suit the needs of the manufacturer of fabrics. This, to my understanding, was not the aim of the writer, who had the retail distributor in mind, and might have considered also the manufacturer's selling force, who are but too prone to amplify on the goods they have to dispose of.

In chapter II are enumerated facts about fabrics such as; the kind of yarn the fabric is made of and the properties of such material, together with the methods of determining these properties. Then the author states, in a general way, how fabrics are made and finished, but in a way sufficiently specific for the buyer of the store. This material is further elaborated upon in the next chapter on wearing and washing qualities of fabrics, which treats also frictional wear and slippage, and the all-important matter of shrinkage in wear and wash.

The next chapter treats the subject of color fastness and chapter V discusses washing, laundering, and drycleaning. Both these matters are very well presented, and reveal a thorough knowledge of the subjects. For this the author ought to be complimented, as well as for his choice of material from the great mass of details embraced by these subjects, which is not at all an easy task.

The last chapter deals with the kind of complaints the retailer receives from his customers. These are analyzed in a very enlightening manner, which brings out that on the average, 40% of the complaints are justified on the ground of defective merchandise; 20% are due to either a wrong choice of materials for the purpose in view, or faulty workmanship in the finished article; and finally, that the remaining 40% of complaints are due to lack of knowledge on the part of the customer in wearing, handling, washing, or drycleaning the fabric.

Out of all this arise the following principal conclusions:

1. That the retail merchant should, to insure correct purchases, either provide himself with an adequately equipped laboratory, run by a competent man; or send the fabrics out to an established laboratory for test, or else make use of the laboratories of his trade association where such exist.

But this policy must be followed consistently, not only once in a while, when the buyer has a hunch "That the cloth does not feel quite right." For unless he does maintain this policy at all times, how can the merchant guarantee his wares to his customers in his advertisements or over the counter?

2. Retail merchants should launch a comprehensive campaign to inform the customers how to treat the garments purchased after they become soiled or otherwise need freshening up after some wear. Some such work has been done by attaching to garments tags bearing the information, but these are usually thrown away along with the price tags, size tags, etc. The matter should be presented in a more forcible and impressive way, such as providing each sales person in the store with some attractively composed leaflets, which he is instructed to hand personally to his customer after the purchase has been made, in this way building up in the customer confidence in the store which shows enough interest in him to guide him in getting the utmost value out of his purchase.
3. An indirect benefit to the retail merchant will develop from following all this, because only those parties will continue to approach him with their goods who are convinced that they can meet his strict requirements. So, in time, misrepresented goods will not even come to his threshold in the salesman's bag.

Altogether, books such as "Textiles on Test" should be encouraged, and read. Moreover, and by all means, the sound advice contained therein should be followed.—Alfred Suter.

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MANUFACTURERS' LITERATURE

In this department we each month list the printed matter issued by manufacturers. Unless otherwise noted, any of the items listed may be secured free upon application to the issuing firm. Manufacturers who have not yet sent in their printed matter are invited to do so.

22 General Radio Experimenter. The November, 1931, issue of this publication features the article "A Bridge-Type Frequency Meter." General Radio Co., 30 State St., Cambridge, A, Mass.

23 Micromax. A leaflet describing the Micromax, an improved potentiometer pyrometer, which brings micrometer sensitivity, self standardization and rapid recording. Leeds & Northrup Co., 4901 Stenton Ave., Philadelphia, Pa.

24 Carbon Dioxide Indicator. A small leaflet entitled, "Dwight Carbon Dioxide Indicator." Dwight Mfg. Co., 565 W. Washington Blvd., Chicago, Ill.

25 High Precision Tools. Catalogue No. 508, entitled "High Precision Linear and Circular Dividing Machines for Laboratories and Works." Other publications of the same company are: Catalogue No. 458, Sip-Gear Testing Apparatus; Catalogue No. 472, Sip-Micrometers, and Catalogue No. 532, Printing and Recording Chronographs. R. Y. Ferner Co., Investment Bldg., Washington, D. C.

26 The Laboratory. Volume 4, No. 5, of this publication contains the following: Leonardo da Vinci; "The Proper Glasses for Those Who Blow Glass," etc. Fisher Scientific Co., 711 Forbes St., Pittsburgh, Pa.

27 Light Measuring Instrument. Circular A-1 illustrates Model 603 which is a new light measuring instrument. The Weston Electrical Instrument Corp., 591 Frelinghuysen Ave., Newark, N. J.

28 Micro-Telescope. A folder describing a toy micro-telescope. Its length, over all, 32 inches. Power-10; objects 1,000 yards away appear as close as 100 yards; or a man so far away that to the unaided eye he seems only one inch high will appear 10 inches high through the Micro-Telescope. Wollensak Optical Co., Rochester, N. Y.

29 Balancing Machine. A circular describing and illustrating globe dynamic balancing machine for rapid and accurate dynamic balance. The Globe Tool & Engineering Co., Dayton, Ohio.

30 Oscillographs. Circular GEA-1422 illustrating a new automatic oscillograph which records in less than one-half cycle. General Electric Co., Schenectady, N. Y.

31 Photoelectric Relay. The essential elements of the Aminco photoelectric relay described in a loose leaf circular are a photoelectric cell with housing, vacuum tube amplifier, sensitive relay, lamp, and necessary connections. American Instrument Co., Inc., 774 Girard St., N. W., Washington, D. C.

32 Arc Lamp. A circular identified as Boog 31 illustrates a vacuum iron arc lamp for spectroscopic work. P. J. Kipp & Zonen, Delft, Holland.

33 Gas Leak Detector. A small folder containing a description of the R. S. Gas Leak Detector. The Refinery Supply Co., Tulsa, Okla.

INSTRUMENTS, 3619 Forbes St., Pittsburgh, Pa.

Please have me supplied with a copy of each piece of Manufacturers' Literature listed below.

.....

.....

Name.....

Position.....

Firm.....

Street and No.....

City.....State.....

NEW INSTRUMENTS

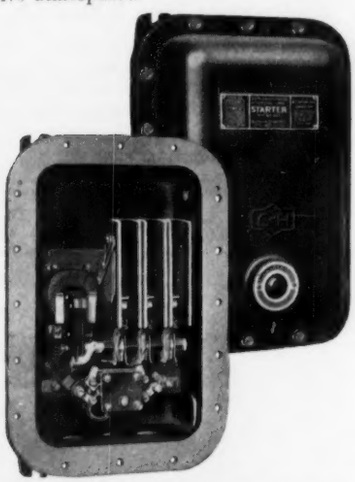
Recently Developed by Manufacturers

Write Information Section, Instruments Publishing Company, for additional Information.

New Explosion Proof A. C. Automatic Starter

Cutler-Hammer, Inc.

THIS new starter is of the air break type—all contacts are made and broken in the air—there is no oil tank. The heavy cast-iron, explosion proof, enclosure is designed to prevent any explosion which might occur within it from igniting the surrounding explosive atmosphere.



The construction of the starter proper consists of a standard 3 pole, magnetic contactor, with C-H thermal overload relays to protect the motor from burnout due to overloads.

The enclosing case is of the "split" type, which, when opened, allows easy access to all parts of the starter. Extra wide and accurately machined flanges are provided between the cover and case.

These starters are designed in 3 sizes, to take care of motors up to 30 HP, 220 volts; and 50 HP, 440 or 550 volts.

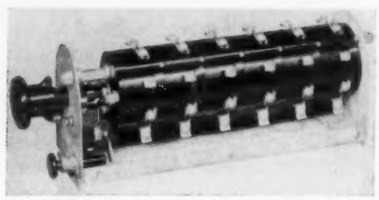
◆◆◆

Pole-Changing Speed-Control Switch

General Electric Company

THESE switches are announced in two sizes, for larger and small squirrel-cage induction motors, for obtaining different speeds by changing the polar grouping of the stator coils.

Unit construction is used, making a wide variety of internal connections possible. This construction also makes replacement of individual contact assemblies possible. By removing tie rod spacers and compound space washers, the movable contacts are accessible for replacement without dismantling the switch.



In operation the speed point is selected by turning the knob handle to the desired position. Depressing the knob completes the main circuits and then picks up the magnetic line switch through the momentary disc contacts. The holding interlock is then closed and the switch latched in this position.

Pressing the "stop" button trips the holding interlock, dropping out the magnetic switch, and then opens the main contacts. Undervoltage protection is thus provided between speed points. Action is very rapid and positive.

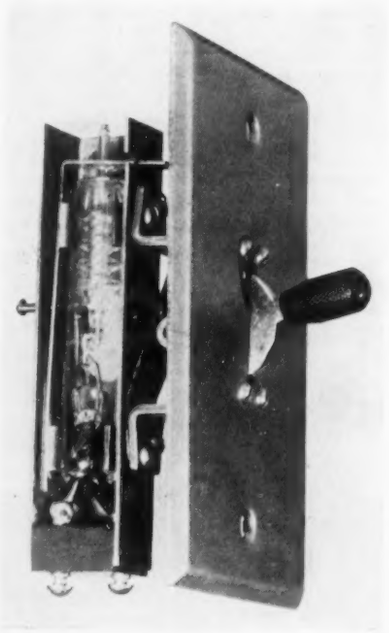
◆◆◆

Vacuum Contact Toggle Switch

Burgess Battery Company

IN this new toggle switch a vacuum contact element is mounted in a holder held by brackets on the rear face of the switch plate. The throwing of the handle to the closed position serves to actuate the external glass stem of the vacuum contact, either making or breaking the circuit as desired. The vacuum contact is exceptionally sturdy, with a practically unlimited life. It is amply protected by the metal holder. There is no movement of body or leads, and no mechanical wear.

The vacuum contact element of the switch is rated at 8 amperes intermittently or 6 amperes continuously, 220 volts. The makes and breaks are clean, free from dangerous arcs, and without corrosion. The contact resistance is extraordinarily low. This switch is especially applicable in places where there is a fire or explosive hazard, or again in precise laboratory practice.



Electro-Limit Comparator

Pratt & Whitney Company

DESIGNED as a means for fast and accurate "selective inspection" in production work, this new comparator is an adaptation of the company's electrical gage. It comprises a cast-iron base carrying an anvil and a column supporting the measuring head, and has a capacity of 4".

Features of this comparator are: an adjustable backstop to facilitate gaging of cylindrical parts; a removable anvil which when reversed, forms a V-block; and rigidity-insuring construction throughout.

The electrical power unit plugs directly into a 110 V. 60 cycle line, and is only 5"x4"x8" in size. A transformer contained in this unit reduces the circuit to 10 V., which is all that is required to operate the gage head. A voltage regulator, also contained in the unit, reduces the inaccuracies of the gage caused by fluctuations in line voltage to about one millionth of an inch for each volt change, which is negligible.

The micro-ammeter mounted on the gaging head has a 2¼" scale. The standard magnification of the circuit will cause the needle to travel about 7/16" for each 0.0001" variation in the sizes of the parts gaged. Magnification can be increased or decreased as desired to suit special conditions.

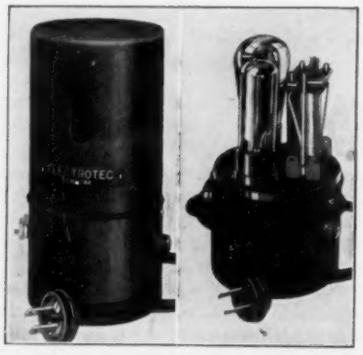
The human element is eliminated when this gage is used, because the gaging pressure remains the same as the pressure with which the gage is set initially. Moreover the high magnification eliminates uncertainties and chances for observational errors. For this reason the gage is serviceable even when used by unskilled operators.

◆◆◆

Phototube Relay

Electrotec Engineering Corp.

THREE models of this phototube relay are announced for a-c., d-c., and battery operation. Features of this type relay are that it may be installed by any inexperienced person; can be adjusted externally to operate on a change



of one tenth foot candle in illumination, or for impulse operating from a light source. Over-all dimensions of all three models are: height 7", 3" diam.

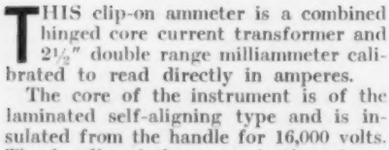
◆◆◆

Clip-on Ammeter

Ferranti, Inc.

THIS clip-on ammeter is a combined hinged core current transformer and 2½" double range milliammeter calibrated to read directly in amperes.

The core of the instrument is of the laminated self-aligning type and is insulated from the handle for 16,000 volts. The handle of the meter is the trigger type and is such that the instrument may be operated with one hand and readily clipped over a conductor or busbar up to 2" in diameter.



The instrument itself has a 2½", 110° open face scale, having two ranges, namely, 0-100 and 0-500 amperes. The accuracy of the meter is within 4% to 3% and readings as low as 10 amperes can quite easily be obtained.

The overall dimensions of the instrument are 11½"x3½"x4", and it comes in a solid leather carrying case equipped not only with a carrying handle, but also a shoulder strap.

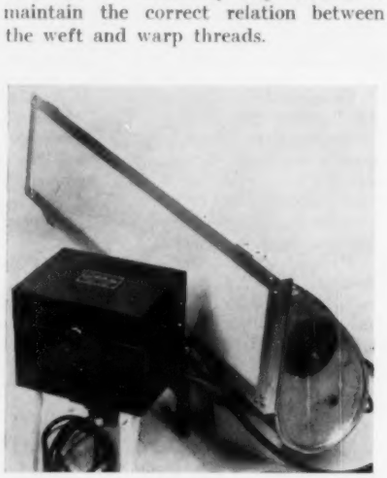
◆◆◆

Vibroscope for Textile Finishing Plants

Electrocon Corporation

ON A tentering frame which is treating light open weave material, it is essential to keep the weft threads perfectly parallel with the warp threads, but it is very difficult and straining to the operator's eyes to follow the weave of the material as it runs through the machine at 30 yards per minute.

A reflector which contains 3 neon tubes and is faced with a sheet of opaque glass to diffuse the light, is placed behind the cloth, and the speed of flashing of the neon tubes is synchronized with the speed of the cloth. This makes the cloth appear perfectly stationary, and it is a very simple matter for the operator to make the necessary adjustments to maintain the correct relation between the weft and warp threads.



Referring to the photograph the unit in the foreground contains an accurately governed motor which regulates the frequency of the light flashes, together with the transformers and other necessary apparatus. The speed of the motor is regulated by turning the knob which projects from the front of this unit. This unit is located at any convenient point on the machine, and operates directly from the light circuit, no batteries being necessary.

◆◆◆

Torsiometer

Coats Machine Tool Co., Inc.

THIS MACHINE is designed for torsion testing of torsion and spiral springs. It consists of a bed with raised head-stock support for the scale and V-guides for the tailstock, with an automatic stop locating the testing position. The spring is mounted on its arbor and, with tailstock withdrawn, is placed into the machine. The tailstock is then moved back along the V-guides up to the automatic stop and locked in this position by the hand clamp shown.

The drive itself is built into a tube, slideably mounted within the tailstock and held by means of a clamping screw. On the outer end of this tube a disc is provided, graduated in degrees, as also a counter for 25 revolutions, a driving crank and knurled collar for locking the drive-shaft under load. The work arbors are equipped with a taper and are attached to the inner end of the tube by means of a chuck.

The scale carries on its inner end a flange with dog, which latter connects with the spring, and on its outer end a weigher beam suitable for both right and left-hand "moments of torsion." A right-hand "moment torsion" would find the weigher beam located in front, as shown in the cut. The scale is designed for a normal max. load of 6 kg. (about 13.2 lbs.) using standard kilogram or pound weights. The beam has an effective length of 10 cm. (about 4") resulting in a "moment of torsion" of 60 kg.-cm. (approx. 52 in.-lbs.) On special request, the scale may be equipped with weights up to a max. "moment of torsion" of 100 kg.-cm. (About 87 in.-lbs.)

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Color Matcher

Westinghouse Elec. & Mfg. Co.

NEARING completion of development is this self-contained, portable, photo-electric color matcher which operates from regular 110 volt power supply.

To compare two samples of color, one of them is put into a deep slot which accommodates a slab of material up to half an inch thick. Then the indicating meter is adjusted to zero by a little dial, the second sample is put into the slot, and the meter reads "darker" or "lighter." A three position handle gives a comparison based on three colors of light-red, green, and blue. Samples which match under all three will be found to match under any light whatever.

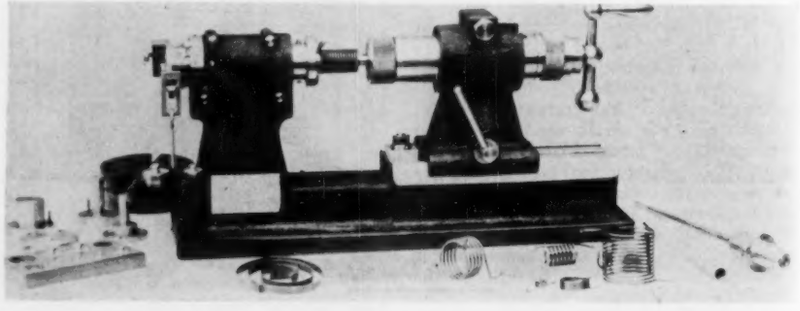
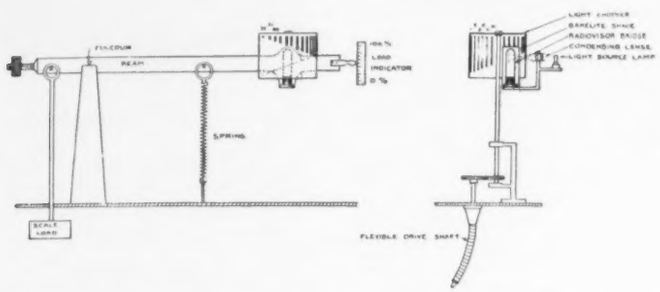


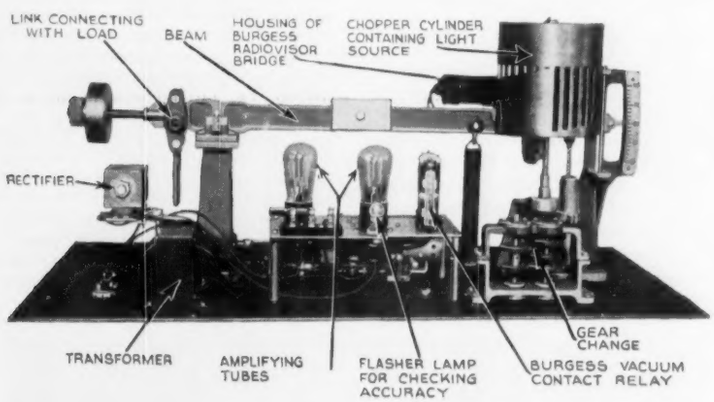
Photo-Electric Conveyor Scale

Burgess Battery Co.

THIS new photo-electric apparatus for measuring and recording the weight of bulky material as it passes along on a conveyor works in the following manner:



At the point where the continuous stream of material is to be weighed, a short section of belt is installed, mounted in such manner that its varying weight is communicated to the weight checking equipment placed directly above. With the varying weight of the load on the conveyor belt, the beam of the weight checking mechanism is actuated. The scale load at one end causes the fulcrumed beam to swing over the scale of the load indicator at the far or free end. This of course indicates the instantaneous weight, but there is still need for some device to keep tally of the continuous procession of varying weights. It is at this point that the electric eye gets to work.

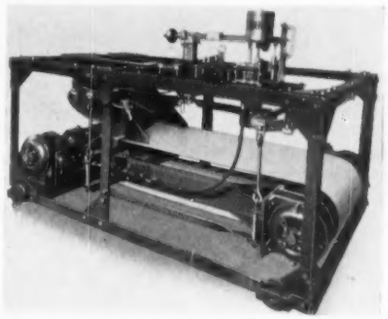


Close to the free end of the swinging beam is mounted a cross arm carrying a Radiovisor bridge or simplified form of light-sensitive cell, and a light source lamp. These members are so mounted that one is outside while the other is inside a revolving light-chopper cylinder which is driven in step with the speed of the belt. The light-chopper cylinder derives its name from the fact that it carries 32 parallel longitudinal slots which serve to interrupt the passage of the beam of light between light source and bridge. However, the slots are of varying lengths. The first is equal in length to the distance traveled by the scale beam from zero to full load. Each succeeding slot is shortened an equal amount at the bottom, so that a line drawn from the bottom of slot 1 around the cylinder to the bottom of slot 32 would form a true helix, touching the bottoms of all slots.

The bridge or cell is mounted in a housing provided with a window directly opposite the sensitive plate. The condensing lens of the light source is adjusted to concentrate an intense beam of light through the window and on to the light-sensitive plate. However, the wall of the rotating chopper cylinder comes between, allowing the light beam to pass only when a slot is in line. Each admission of light reaching the bridge sets up an electrical impulse, which impulse in turn drives the mechanism of the integrator that keeps tally, as well as the time chart recorder.

With no load on the belt the free end of the beam is down, with the focused point of light just below the bottom of slot 1 of the chopper cylinder. Hence no impulses result since no light reaches the bridge. However, as load is placed on the belt the beam swings upward proportionately, bringing the focused point of light higher and higher on the chopper cylinder, so that more and more slots admit light and cause a corresponding number of impulses to actuate the electrical integrator. The number of impulses are always proportional to the load, from zero to the capacity at which the scale is calibrated. At full load there are 32 contacts per revolution of the chopper cylinder. With 350 contacts per minute and a belt speed of 350 feet per minute, an impulse is obtained for each foot of belt, which is representative of a certain amount of material passing over the scale.

Balancing the scale is a simple operation. A test weight is provided which represents exactly half load when hung



on the beam. A switch serves to cut out the integrator and throw in a small lamp which flashes at each impulse. A change gear is provided, which slows up the revolutions of the chopper cylinder so that the flashes may be counted. With no load on the moving belt, there should be 16 flashes for each complete cycle if the machine is properly balanced. If out of balance, the scale is balanced with a balance ball as required, until 16 flashes are obtained per revolution. The test weight is then removed.

The bridge, light source and chopper cylinder serve to produce the necessary electrical impulses which are amplified by means of a two-stage amplifier. The amplifier output operates a relay capable of handling all the current required for the operation of one or more integrators or counters, which may be located at any distance from the scale. A rectifier converts stepped down a.c. into low voltage d.c., for the operation of the integrator and scale chart, in accordance with the makes and breaks of the vacuum contact relay. The integrator is simply an electro-magnetic counter with a number of units to represent the grand total of integrated weights.

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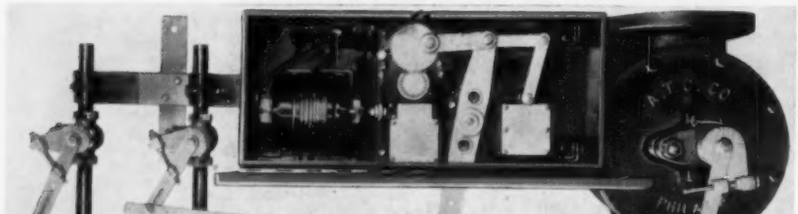
Motor Operated Controller

Automatic Temperature Control Co.

A RECENT development in automatic valve controllers is a multi-position motor operated controller, known as Type 303. The user can connect this controller to the actuating instrument so as to obtain either two or three position operation depending upon results desired. When wired for three position operation either three or four valve positions can be obtained by a simple mechanical adjustment of the limit switch.

The Controller is mounted with one air and two fuel oil valves—desirable practice where fuel oil burners on both sides of a wide hearth furnace are to be handled with one controller, for with two fuel valves the supply can be adjusted



individually to both sets of burners, thus insuring equal fuel distribution to both sides of the furnace.

Printed matter on Type 303 Controller lists several types of furnaces where the high and low valve settings are necessarily wide apart in order to handle on continuous type furnaces, both maximum load and standby conditions or on batch type furnaces, for quickly heating up and for holding conditions. With the ability to adjust its valves to one or two intermediate positions, this new controller can hold continuous type furnaces under very close temperature regulation and do it entirely automatically. To obtain like results with a controller not designed to select intermediate valve position, it would be necessary to resort to semi-automatic control.

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Boiler Water Level Recorders

Bailey Meter Co.

TO MEET the present trend of boiler design toward smaller water storage space, higher ratings, and higher pressures, this new line of boiler drum water level recorders and indicators was developed. These devices give operators a complete picture of the rate of change of water level and show the true level throughout the full range of the drum, which is not possible with the gage glass. Records of water level are also of great value in preventing or determining the causes of boiler failures.

This water level recorder operates on the difference in level obtained by making two connections to the water column or boiler drum; one connection being made to the water space, and the other to the steam space where a constant water head is maintained in the connection by means of a steam condensing radiator and a reservoir. The variable head or water space connection is applied over a mercury sealed bell and the constant head connection is applied to the inside of this bell. As the boiler water level rises or falls, the mercury sealed bell falls or rises and this motion is transmitted to the recording pen by a forked lever and a spindle which turns in pressure-tight bearings. A reversing linkage is employed between the spindle and recording pen so that the pen moves upward as the water in the boiler drum rises and moves downward as the water level drops.

The water level recorder may be incorporated with a feed water flow meter to record the two related factors on one chart for easy comparison. Remote indicators or recorders operating from the main recorder can be placed at other points, if desired. A large variety of types and combinations are available in all pressures standards up to 1800 lbs./in.^{2}.

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Meg Ground Tester

James G. Biddle Company

THIS new ground tester is an adaptation of the existing "Megger" ground tester, to meet the need for a small, light-weight, direct-reading ground-resistance measurer. Ground resistance is measured with alternating current generated by a self-contained generator. Readings are obtained on a direct-current ohmmeter by using a reversing commutator on the generator

shaft to make the current unidirectional through the meter.

Features of the instrument are: light weight, small size, and a scale expanded at the low ohmage end, to facilitate reading of low resistances.

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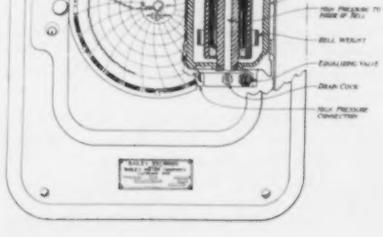
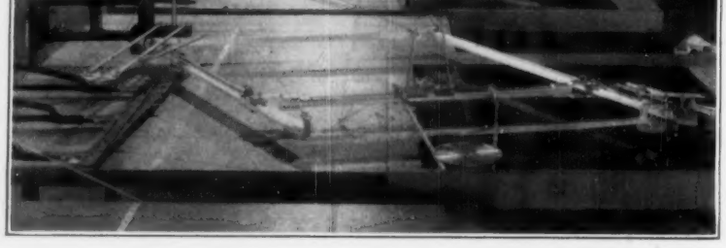
Improved Pantographer

Gaertner Scientific Corp.

THE essential part of the instrument consists of four rigid arms jointed in the form of a parallelogram upon a principle similar to that of the reducing pantograph. Three of the arms have graduated scales with verniers which permit setting for the various ratios of reduction required.

The compensating device is controlled by two auxiliary pantograph arms, which are so proportioned and placed on the main pantograph as to form a secondary pantograph with a fixed reducing ratio. This secondary pantograph is connected with the copy board by means of a graduated compensating bar and a connecting rod. This compensating device can be set to restore automatically the correct dimensions of a distorted map or chart. The amount of movement the compensating bar transmits to the copy board through the connecting rod is controlled by an adjustable pivot point fastened to the compensating bar. The pivot point is free to move longitudinally between rails which are rigidly held in place so as to prevent any lateral movement of the pivot point to the right or left. The copy board is mounted on ball-bearing rollers so as to permit any right or left movement transmitted to it through the compensating device.





Spectrogram Measuring Comparator

Gaertner Scientific Corp.

THIS comparator is especially designed for measuring spectrograms but may also be used very conveniently for comparing scales and measuring linear differences on any objects which can be placed on the stage.

The outstanding features of this instrument are great compactness, greatest accuracy of the micrometer lead screw, full protection of all delicate parts, measuring microscope of variable power and with improved focusing motion, and large stage capacity.

In regard to the absolute measurements, provision is made in the comparator for correcting the total length of the screw by giving the nut an independent rotation backwards or forwards. A bar is placed in line with the lead screw which controls the rotation of the nut and, if placed accurately parallel with the lead screw, will guide the nut without rotation. If after a test the screw proves to be long or short, the bar is inclined accordingly and an independent rotation given to the nut, which takes care of the adjustment for total length. The total length of the comparator is adjusted at a temperature of 22½° C. and usually made accurate to within .001 mm., but as the absolute length of measurement is not essential in spectrographic work, the total length may vary as much as .006 mm.

Each individual comparator is accompanied by a certificate guaranteeing its accuracy and specifying the absolute total length at the given temperature.

The screw carries a graduated drum for making readings direct in 0.001 mm. The microscope is mounted on a stationary arm firmly attached to the rear of the bed plate of the comparator.

The lead screw has a large diameter (17 mm.) and a pitch of 1 mm. It is accurately corrected to eliminate periodic and progressive errors.

The micrometer drum is 135 mm. in diameter and is accurately divided into 1000 parts. The lines and figures are white on black. An adjustable magnifier enhances the facility of reading from a convenient distance.

The screw also carries a bakelite disc 90 mm. in diameter and a hard rubber handle. The handle is convenient for rapid rotation of the screw and the large disc permits very delicate settings. The bakelite prevents conduction of heat from the hand to the screw to bring about consequent errors. The full revolutions of the screw are read on a millimeter scale attached to the body of the instrument. If desired, a second drum, coaxial and adjacent to the micrometer head, and read by the same magnifying glass, can be supplied for reading the full revolutions of the screw. This arrangement is more convenient than reading the millimeter scale, and gives less strain to the eye.

Two objectives of 32 mm. and 36 mm., and two eyepieces of 25 mm. and 50 mm. equivalent focal length are supplied with each instrument. By interchanging the objectives and the eyepieces, and making use of the various tube lengths. magnifications between 5 and 35 diameters can be obtained. A table is supplied giving all possible magnifications, using the different optical parts at different tube lengths.

A swivel holder which contains a mirror and a white diffusing surface permits the use of either for illumination of transparent objects from below. It is located in the base of the instrument in line with the microscope, and receives light from any suitable external source behind the comparator.

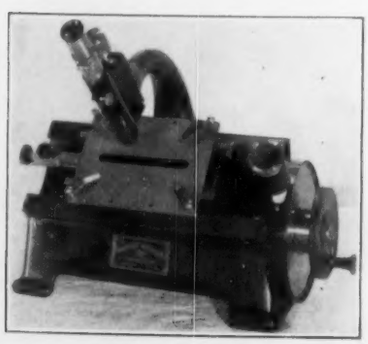
A weight attached to a cord which passes over a small pulley maintains the carriage always in contact with the nut, and keeps the screw against the end thrust.

The comparator is supported on three points, two in the front and one in the rear, which make the support stable on any surface.

The guides, the screw and nut, and the micrometer head are carefully and neatly shielded from dust and injury by heavy steel shields.

The stage is fitted with four clips for holding the plate in position, and will accommodate plates up to 4″ wide. The plate can extend without limit toward either end. Because of the additional slide parallel to the carriage, repeating measurements can be made over 160 mm. on an opaque object without moving it on the stage. The extra slide is especially convenient for aligning work with respect to the motion of the carriage.

Special requirements regarding magnifications or accommodation of special objects can often be met at slight additional cost.



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Carrier-Current Load-Control

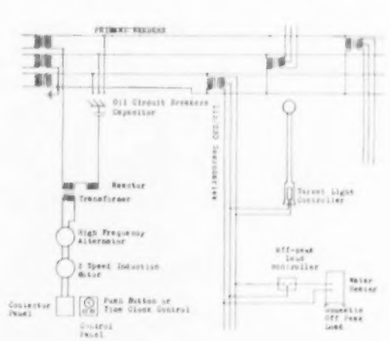
General Electric Company

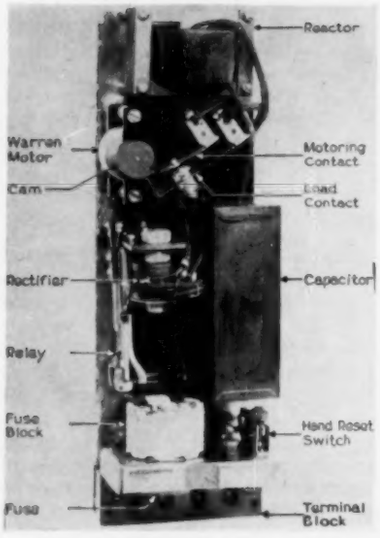
MANY advantages of controlling the loads on a power network directly from the power distributing station are made economically available by this new carrier-current control. "Carrier-current control" means using the power line itself for control transmission, by using a "carrier-current" superposed on the line—a current which is not interfered with by the power current because widely different from it in frequency. Therefore, by manipulating the carrier current, one can operate from the power station and without separate control wiring, any number of controls for any number of loads, for utilizing off-peak power, maintaining operating schedules, etc. The workings of the system are in detail as follows:

At the distribution substation a motor-alternator feeds carrier current of 480 or 720 cycles into the primary feeders. This superimposed control energy travels along the feeders and is then stepped down to the 115 volt secondary circuits by the distribution transformers in essentially the same manner as the 60 cycle power voltage. At desired points along the 115 volt secondary circuits, tuned relays respond directly to the 480/720 cycle carrier current. On a carrier impulse of approximately 10 seconds, the load contactors controlled by these tuned relays close the load circuit, and open them on an impulse of approximately 35 seconds. Operation can be effected simply by pressing an on-and-off push-button at the distribution substation. When it is desired to open or close a group of loads, the proper button is pressed, causing the motor-alternator to start. After sufficient time has elapsed to assure normal speed of the motor, the high-frequency voltage is impressed upon the feeder circuits for the proper time interval, after which the equipment automatically shuts down.

This system of control can be applied to practically any distribution network, whether of underground or overhead construction, or a combination of both. For average substation areas, the output requirements of the transmitter equipment range from 1 to 25 kva. The transmitter and the control equipment can be arranged to energize successively each phase of the substation feeder bus or, in the case of primary street-light control, all controllers can be placed on the same phase of the 115-volt secondaries and thus permit a simplification of the transmitter control apparatus.

The transmitter equipment of this new carrier-current control consists of a two-speed motor-alternator of 480/720 cycles output, a master control panel and contactor panel, a high-frequency output transformer, tuning inductance, and coupling capacitor. Low-capacity breakers or contactors are used to connect the transmitter successively to the three phases of the feeder bus, to a single feeder, or simultaneously to all three





phases, depending on the specific arrangement of the transmitter equipment.

There is one design of controller for street-light control and another for the control of domestic off-peak loads. Both respond to the same "on" and "off" timing impulses, so the same transmitter can be used to actuate both types. However, in order to maintain independent time schedules, each type is designed to operate at a different frequency from the other. A frequency of 480 cycles is usually employed for streetlight control, and 720 cycles for domestic off-peak load control. The load-contact mechanism of the street-light controller can be modified to accommodate an all-night-midnight lighting schedule on the same control frequency without in any way restricting the use, at the same time, of the same transmitter for domestic off-peak load control also.

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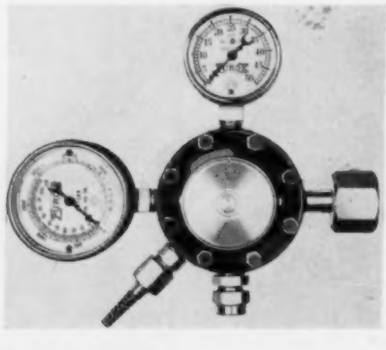
Gas Flow Regulators

Linde Air Products Company

THESE new regulators are improved forms of regulators produced for delivering to the welding blowpipe tip, or cutting blowpipe, at uniform pressure, the required volumes of oxygen and acetylene essential for maintaining a neutral flame.

One of the outstanding design features of the new regulators is an accurate self-aligning valve of the nozzle and yoke type, insuring sensitive action and freedom from leakage. Simplicity of construction also eliminates any need of disturbing the diaphragm, bonnet, pressure adjusting screw, or pressure adjusting spring when replacing a worn valve seat. Access to the interior of the regulator is gained by merely removing a plug in the rear of the body. A rupturing disc safety release on the oxygen regulator provides protection to the diaphragm should an abnormal pressure occur. Although seldom if ever necessary, the operation of replacing the diaphragm is quite simple. The cap bolts are merely removed and the diaphragm and yoke lifted out, no special tools being required.



Gauges for these new regulators are heavy and well made in order to withstand the incidental rough usage of field work. The working pressure gages are 2 in. and the cylinder pressure gauges 2½ in. in diameter.

In accordance with the standard color specification for oxy-acetylene equipment, oxygen regulators are painted green, and acetylene regulators red.

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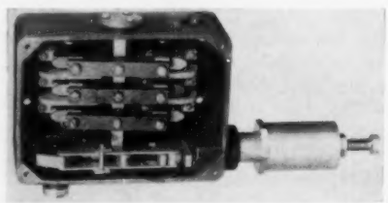
Foot-Operated Snap Switch

General Electric Company

INTENDED for rough-duty installations, and provided with a weatherproof cast-iron enclosing case, this new switch is rugged enough to be used in steel mill applications. The switch can be



foot-operated, and mounted in any position. It has a positive snap action in either direction. All bearings are made of an oil-less bearing material, consequently no lubrication is needed after installation.

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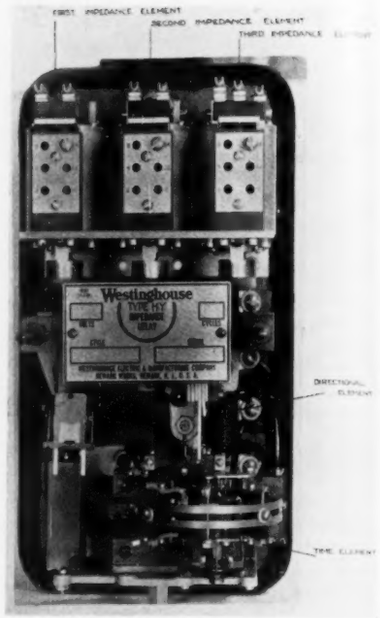
Protective Distance Relay

Westinghouse Elec. & Mfg. Co.

IN ORDER to provide, for power networks, a protective relay the operation of which depends on the distance of the fault, this new relay was developed. It is intended for application on the shorter line sections where the arc resistance may reach a value comparable to the line impedance.

The principle employed in this relay is particularly valuable in that it imparts a wide flexibility to the distance measuring characteristic. It can be applied to any or all of the three elements and allows the relay to operate on any sort of characteristic which experience may indicate is desirable.



Essential features of the relay are the following:

1. A pure impedance distance element which protects 80% of the line and which is capable of extremely high speed. This element operates before the arc resistance has a chance to assume a value large enough to materially affect the action of the impedance element.

2. A timed distance element to protect the remaining portion of the line. This element has a composite impedance reactance characteristic which renders it substantially independent of fault resistance without requiring the complication of a lock-out device.

3. A timed back-up impedance element which can be set for a distance long enough to swamp the effect of fault resistance.

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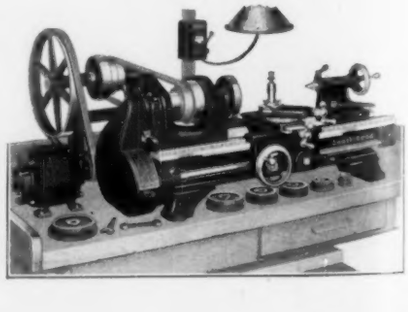
Small Shop and Laboratory Lathe

South Bend Lathe Works

THIS equipment unit is a precision lathe said by the manufacturers to be capable of performing the most accurate work. Available in countershaft and individual motor drive, the lathe is built with a back-geared headstock with 3 step cone providing 6 changes of spindle speeds—3 direct for light machining at high speeds and 3 back-geared for heavier work and slow speeds.



Bed lengths supplied are 24", 30", 36" and 42". All types of turning, facing, boring, drilling, etc., may be done with this lathe and attachments are available for special work, if desired. Motor driven lathes are equipped with 1800 R.P.M. motor, belts, etc., and come ready to run as soon as connected with an electric lamp socket.

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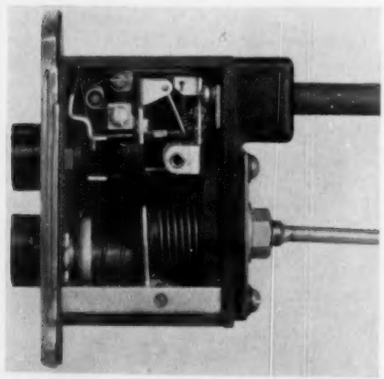
Control Unit for Refrigerators

General Electric Co.

THIS new control unit is designed for controlling the compressor motor on alternating-current domestic electric refrigerators.

It incorporates an "on-off" switch, the "off" position being used for defrosting; a thermal overload device to protect the motor against sustained overloads; a knob for manually resetting the relay; and an adjusting knob for varying the temperature in the food chamber; as well

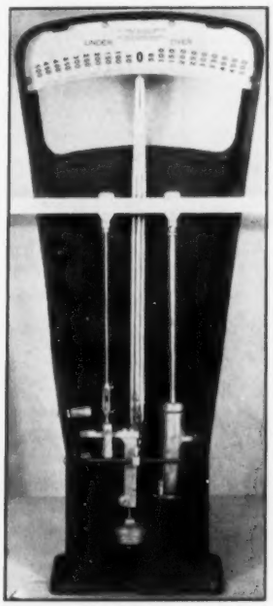


as a flexible metallic bellows and tube, the end of which is to be mounted on the evaporator or coil. The unit is designed for convenient mounting either on a standard or on the evaporator plate inside the refrigerator. It may also be flush mounted on the outside of the cabinet.

Pendulum Balance Scales

Hamblin Accurate Weigher Co.

THIS NEW type of scale indicates weights by the amount they deflect a vertical pendulum. Only one moving element is used—the vertical pendulum, which is balanced on knife-edges. All springs are thereby eliminated. Advantage claimed over beam-scales are:



freedom from friction in the bearings, insuring accuracy; quick coming to rest of pendulum without aid of dashpots; increased speed and visibility because reading is taken at whatever point pendulum pointer is deflected to, in contrast to waiting for beam to come to exact balance. A wide range of sensitivities and capacities are available in stock units, or units built to specification.

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High Range Manometer

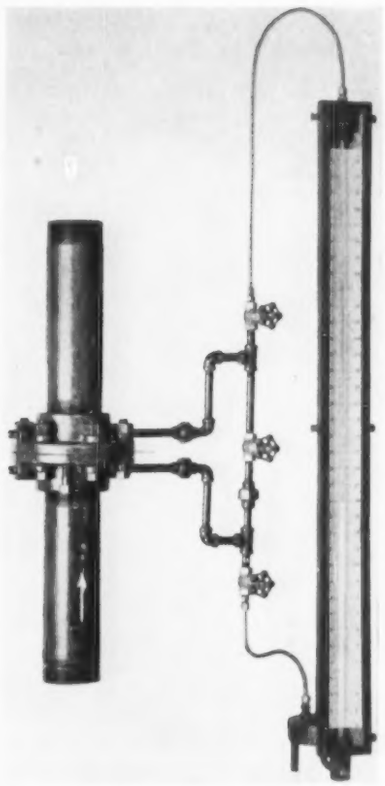
The Meriam Co.

THE PURPOSE of this instrument is to supply a light, portable instrument for checking the accuracy of recording flow meters.

This instrument has a steel frame, stainless steel gland packers, plate glass cover, and is tested to one thousand pounds hydraulic pressure.

Mercury, water, or Meriam No. 3 Fluid, having a specific gravity of 2.97, may be used. With the No. 3 Fluid this Manometer will read one hundred inches of water. The standard scale is thirty-five inches long, the right side is graduated inches and tenths, and the left side zero to one hundred inches and tenths of water using Meriam No. 3 Fluid.

This instrument can be used as an indicating flow meter and company will supply at a small additional charge the orifice plate, orifice flanges, special scales reading direct in gallons, cubic feet, pounds or any commercial units of measurement, liquid return well, control and



bypass valves. In this case it will only be necessary for the user to run the pressure connections from the orifice plate to the high and low pressure sides of the instrument.

The standard instrument is 42 inches high, 6 inches deep, 4½ inches wide and weighs approximately 20 pounds. Special instruments of any length and for higher pressures can be supplied.

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New Hygrostat

Barber-Colman Company

THIS hygrostat is designed to meet the demand for an inexpensive, well constructed instrument for controlling humidifying apparatus by electrical means. It is essentially an automatic two-way switch operated by changes in the length of a wood cylinder as it reacts to changes in atmospheric moisture content. The hygrostat not only actuates controlled mechanisms on a variation of less than 4% in relative humidity, but indicates the existing humidity by means of a pointer and scale mounted in the instrument.

The hygrostat is mounted upon an insulating base of phenolic resin, and protected by a moulded cover of the same material. All metal parts are rust-proofed.

New Telescope

Bausch & Lomb Optical Company

FOUR EYEPIECES are provided with this new telescope giving magnifications of 12, 19, 25 and 35 powers, respectively. This wide range of magnifying power makes the instrument usable at distances ranging from 40 feet upwards. Ample power is provided for the observation of the more interesting celestial bodies.

The telescope is provided with a leather carrying case and shoulder strap, and may be carried as easily as a camera or binoculars, the weight of the instrument and case being only three pounds.

Two tripods are available, a small all-metal stand which is designated as the table model, and a collapsible wooden tripod, or floor model, the use of which brings the instrument to normal eye level when the observer is standing.

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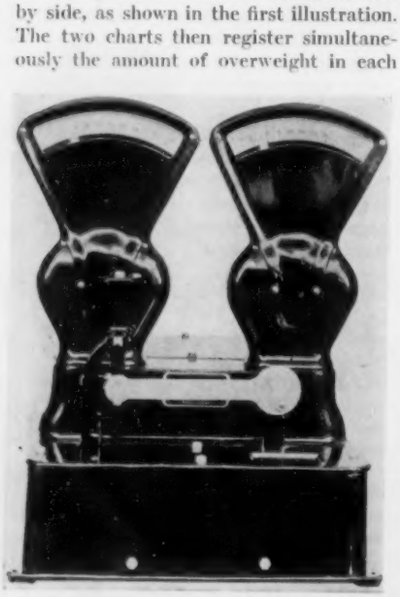
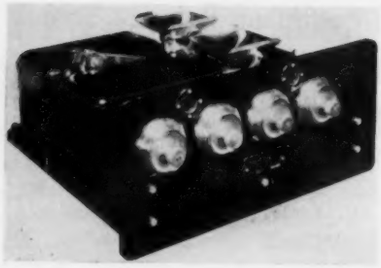
Connecting Rod Testing Auto-Gage

Toledo Precision Devices, Inc.

THE DEVICE consists of 2 separate machines. One of them performs the initial weighing of the connecting rod. Formerly, each end of the connecting rod had to be weighed separately. With this new device, both ends of the connecting rod are attached, at the same time, to two instruments mounted side by side, as shown in the first illustration. The two charts then register simultaneously the amount of overweight in each





end of the rod. Hence, the waste of time which existed when each end of the connecting rod was weighed separately, is eliminated.

After the amount of overweight has been ascertained, the operator sets the dials of the machine, pictured in the second illustration, to coincide with the figures on the charts. This second machine consists of 2 instruments with receiving pans. An automatic cut-off device is connected with a shaving machine placed next to it. The connecting rod is placed in the shaving machine and pared to the proper diameter, at which point the automatic cut-off stops the operation. Loss of time resulting from shaving each end of the connecting rod separately is thus eliminated.

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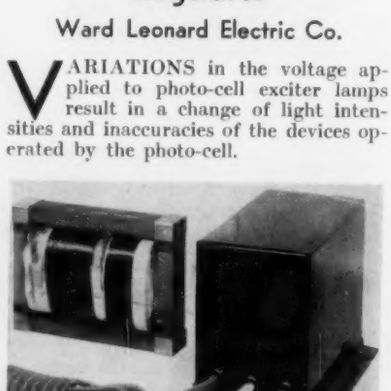
Constant Wattage Voltage Regulator

Ward Leonard Electric Co.

VARIATIONS in the voltage applied to photo-cell exciter lamps result in a change of light intensities and inaccuracies of the devices operated by the photo-cell.



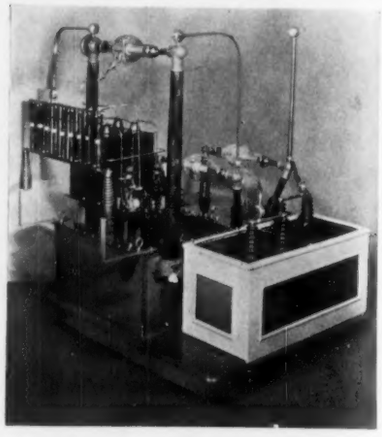
Combined in this unit are a voltage transformer and regulator reducing the alternating current line voltage to that required by the exciter lamp, and maintaining the exciter lamp voltage constant regardless of instantaneous fluctuations in line voltage. The greater the line voltage fluctuation and the closer the regulation required, the larger is the size of the regulator for a given load.

The design of the regulator is such as to compensate for commercial manufacturing variations in lamps of the same nominal rating and to correct for the increase in lamp resistance with aging. If a lamp filament is low in resistance, the regulator supplies reduced voltage. If a lamp filament is high in resistance, or if it has increased in resistance due to aging, the regulator supplies increased voltage. Thus, lamps are run at constant wattage, assuring a constant intensity of light with the resultant accuracy and precision of operation of the photo-cell device.

High Speed X-Ray Machine

Westinghouse X-Ray Company

AN X-RAY snapshot in less than 1/1000th of a second is made possible by this new machine, which uses a 3-element Westinghouse X-ray tube. This enables physicians to see clearly, for positive diagnosis, the inside of a human body, which up to this time was impossible because blurred by the motion of



the patient's muscles. There are undoubtedly industrial applications where this high-speed feature is of similar value, but these were not mentioned. An interesting feature of this new apparatus is that it can be operated from an ordinary house lighting circuit.

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Constant Speed Universal Motor with Electric Governor

Bodine Electric Company

ACCURACY approaching clock time and rapid acceleration are features of this new line of series motors with improved electric governors. The new governor used is the same reliable one as is used in talking motion picture equipment, electric pyrometer control drives, etc.

In the design of these motors, the electrical constants of the governor are carefully calculated to meet the requirements of the duty cycle and operating cycle of the load.

These motors are available in two forms: one with speed adjustable while running, the other adjustable at standstill only.

INSTRUMENTS ABSTRACTS

Abstracts on instruments and devices for measurement, inspection and control.

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An improvement we hope to make in the Abstracts Section in the near future is the cross-indexing of articles which fit under several sections. We suggest glancing through the whole Abstract Section. This takes but a short time, and the time so taken will be found very profitably spent.

The classification number at the end of each abstract will be of assistance in mounting them on file cards.

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CLASSIFICATIONS

(By Fields of Reader Interest)

MEASUREMENT TECHNOLOGY (1)
This section includes all matters concerning the art and science of measurement as follows:
Measurement Theory (1.1)
Under this heading will be included: definitions, precision of measurements, systems of units, and dimensional analysis.
Measurement Practice (1.2)
Covers Calibration and Standardization.
Calculation (1.3)
This does not include computation for instrument design, but covers calculations as a mode of measurement.

MEASUREMENT and CONTROL (2)
This section is devoted to those general measurement practices and control applications that are not confined to any one industry or branch of engineering. Thus temperature measurement and control, being of as much importance in chemical as in metallurgical processes, is a general field of interest to all industries and all branches of engineering.
Length, Angle, and Area, Including Surveying (2.01)
Time, Speed, and Acceleration (2.02)
Weight, Density, and Specific Gravity (2.03)
Pressure and Vacuum (2.04)
Flow and Volume (2.05)
Temperature (2.06)
Heat and Combustion (2.07)
Humidity and Moisture (2.08)
Power, Work, and Output (2.09)
Physical Properties, (Viscosity, hardness, elasticity, plasticity, surface tension, etc.) **(2.10)**

TESTING and INSPECTION (3)
Physical Testing and Inspection (including strength tests, bending, magnetic analysis, X-ray inspection, and other engineering test or inspection methods.) **(3.1)**
Production Testing and Inspection (This includes methods of testing and inspection for setting up production standards, grading, gaging, maintaining quality, etc.) **(3.2)**
Maintenance Testing and Inspection (Included here will be matters concerning standards and methods for controlling performance or service of equipment. Example—The problem of controlling long phone lines to give quality sound transmission would be included here.) **(3.3)**

ELECTRICITY and MAGNETISM (4)
Electrical Properties, Tests, Measurements, and Measuring Instruments (4.1)
Electrical Measuring Devices and Applications (4.2)
Magnetic Measurements (4.3)
Magnetic Properties Materials, and their Applications (4.4)

ELECTRONICS and RADIO (5)
Radio Measurements (5.1)
Applications of Radio to Measurement and Control (5.2)
Photo-electric Measurements, Devices and Applications (including television) **(5.3)**
Electronic Measurements, Tubes, Devices, and their Applications (Under this heading would be included thermionic tubes, grid-glow tubes, thyratrons, neon discharge tubes, cathode-ray tubes, etc.) **(5.4)**

ACOUSTICS and VIBRATIONS (6)
Sound, Vibration, Phenomena and Measurements (6.1)
Sound and Vibration Devices or Applications (6.2)

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LIGHT, OPTICS, and RAYS (7)
Light—General Measurements and Optical Applications (7.1)
Color Analysis, Color Matching (7.2)
Photometry (7.3)
Polarimetry (7.4)
Spectrometry (7.5)
Photography (7.6)
Microscopy (7.7)
Electromagnetic Rays (This heading covers all electromagnetic rays other than visible light: infra-red, heat rays, ultra-violet, X-rays, alpha, beta, gamma, cathode, and cosmic rays.) **(7.8)**

CHEMISTRY (8)
Under this heading will be chemical measurements, analysis, and their control applications.

ASTRONOMY, NAVIGATION, AVIATION (9)
Included in this section will be, besides usual matters concerning astronomy, navigation and aviation, special matter on direction-control such as range finding, direction finding, radio beacons, etc.

GEODESY, GEOLOGY (10)
In this section will be covered seismology, geophysical prospecting methods, etc.

INSTRUMENT DESIGN and CONSTRUCTION (11)
Matters concerning new instruments, their design, operation and manufacture, will be included under this heading.

GENERAL and MISCELLANEOUS (12)
This section will include: First; general items of interest to all in the field of measurement and control. Example—"Possibilities of Vacuum Tubes for Application to Measurement and Control" is an article of universal interest in the fields of measurement and control. Second; miscellaneous items of general interest because not includable under any of the above classifications. Finally, items of general interest to all fields of measurement and control, such as historical material, biographical, etc.
General (of interest to all in measurement or control fields) **(12)**
Miscellaneous (12.2)
Historical and Biographical (12.3)
Bibliographical (12.4)
Economic (12.5)

CONTROL FUNCTIONING EQUIPMENT (13)
Literature on the equipment used by operators or automatic controllers to perform their control functions will be covered under this heading. For example, the drum controller and associated switches, rheostats, relays, and motor starters by which an operator controls the motion of a crane are all pieces of "control functioning equipment."
Mechanical Control Functioning Equipment (13.1)
Electrical Control Functioning Equipment (13.2)
Includes drum controllers, relays, solenoids, etc.

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Length, Angle & Area, including Surveying (2.01)

A Suspension Theodolite for the Oil Mining Industry. (Ein Haengetheodolit fuer den Oelbergbau.) K. Luedemann, Zeitschrift fuer Instrumentenkunde, Vol. 50, July 1930, pages 423-426.
Instrument brought on the market by the Max Hildebrand Co., Freiberg, Saxony. Modification of the former theodolite in order to meet the conditions prevailing in oil mining industry. E.F. (2.01)

A New Self-reducing Tachymeter of the Three-image Type. (Ein neues selbst-reduzierendes Tachymeter. Dreibild Tachymeter.) R. Hugershoff, Zeitschrift fuer Instrumentenkunde, Vol. 50, Sept. 1930. pages 526-530.
Consists of three rigid telescopes and allows the simultaneous determination of the vertical and horizontal projection on a horizontal thread due to a combined field of view. E.F. (2.01)

Time, Speed and Acceleration (2.02)

An Automatic Race Timer. Edwin A. Speakman. Review of Scientific Instruments, May 1931, pages 297-304.
The instrument described is used to time races by the use of a microphone, a photoelectric cell, an amplifier, and a clock. The time is recorded in 1/120 of a second from the instant when the sound of the starting gun reaches the runner's ear, to the instant when the runner's chest touches the tape at the finish. (2.02)

On an Adjusting Device for Half-second Pendulums of the Stueckrath Type. (Ueber eine Abstimmvorrichtung des Halbsekundenpendel Stueckratscher Form.) M. Roessiger, Zeitschrift fuer Instrumentenkunde, Vol. 50, Sept. 1930, pages 552-554.
Device consists of an adjustable gold weight to obtain coinciding oscillation periods of pendulums. E.F. (2.02)

On the Influence of the Earth's Magnetic Field Upon the Oscillation Period of Nickel Steel Pendulums. (Ueber den Einfluss des erdmagnetischen Feldes auf die Schwingungszeiten von Nickelstahlpendeln.) M. Roessiger, Zeitschrift fuer Instrumentenkunde, Vol. 50, Sept. 1930, pages 551-552.
A new source of error was disclosed, ascribed to the large permeability of Fe-Ni-alloys. E.F. (2.02)

The Riefler Clock with Gravity Escapement. (Die Riefleruhr mit Schwerkrafthemmung.) H. Bock, Zeitschrift fuer Instrumentenkunde, Vol. 50, Jan. 1930, pages 109-117.
The precision clock of the Riefler Co., Munich, is described, in which the pendulum spring is abolished and replaced by an edge-suspension. E.F. (2.02)

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WRITE FOR LITERATURE

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The Stroboglow. W. Endres Bahls & D. D. Knowles, Electric Journal, Vol. 28, Apr. 1931, pages 250-253.

This instrument is a rugged portable stroboscope which gives excellent definition. The true behavior of the various parts of a machine having periodic motion can usually be learned only when the machine is in normal running operation.

The stroboglow is designed to permit the study of moving parts in out-of-the-way places. It is portable, self-contained, and is packed in two large-size suit cases. There are no moving parts and expert service is unnecessary. It has a broad speed range. The requisities of the ideal stroboscope are summarized as : (1) ruggedness, (2) portability, (3) simple and effective control of large currents, (4) exceedingly short duration of light pulsations, (5) very intense light pulsation, (6) minimum of moving parts, (7) simplicity of operation, and (8) accuracy of timing light flashes. The stroboglow, it is claimed, fulfills these requirements. It consists essentially of the oscillator or interrupter, and the light unit. The heart of the light unit is the power grid-glow tube. The instrument is illustrated, and the oscillator circuit shown in diagram. Various applications are indicated. W.H.B. (2.02)

The Influence of Gravity on Centrifugal Regulators With Electrical Contact Regulation. (Der Einfluss der Schwerkraft auf Fluchkraftregler mit elektrischer Kontaktgebring.) W. Dornig. Elektrot. Zschr., Vol. 52, Aug. 6, 1931, pages 1031-1033.

It is shown that gravity has a noticeable influence on sensitive centrifugal regulators with horizontal axis. The eccentricity in the movement is calculated and found to depend on the circumferential speed. Good modern regulators are so built that they hold a uniformity of motion of 1 per mille with certainty. A construction is described. Ha. (2.02)

A Clock which Need not be Wound Up. (Eine Uhr, die man nicht aufzuziehen braucht.) B. Schmidt-Staub, Umschau, Vol. 35, March 21, 1931, pages 228-229.

The Electronom of the Junghans Co.-Schwamberg is considered. Clock can be hooked-up with 110 or 220 volt a.c. or d.c.

Every minute the current is switched in and heats a coil in a compressor lamp, which moves a small piston. The mechanical work of winding-up is performed by the piston. E.F. (2.02)

Weight, Density and Specific Gravity (2.03)

The Determination of Volumetric Weight and Specific Gravity of Moist and Dry Gases. (Ueber die Ermittlung des Raumgewichts und des spezifischen Gewichts von feuchten und trockenen Gasen.) L. Zipperer. Die Messtechnik, Vol. 7, June 1931, pages 153-154.

Derivation of equations for the determination of these quantities from measurements with the Bunsen-Schilling apparatus and a table for correction coefficients at different temperatures. Ha. (2.03)

A New Pycnometer. (Ein neues Pyknometer.) F. G. Hoffmann, Chemiker Zeitung, Vol. 54, Dec. 3, 1930, pages 936-937.

A simple needle point pycnometer is described for determination of the specific gravity of both solid bodies and liquids. E.F. (2.03)

Up-to-Date Weighing Contrivances in Gas Plants. (Neuzeitliche Waagen im Gaswerksbetrieb.) P. Patermann, Gas & Wasserfach, Vol. 73, March 8, 1930, pages 233-234.

The different installations available, mainly referring to coal weighing machines, are given. E.F. (2.03)

Factors Involved in Large-Capacity Weighing. J. J. Harrison. Scale Journal, Vol. 17, July 1931, pages 4-6.

The discrepancies between shipping weight of coal on the railroads and the weight which the retailer of the coal finds are discussed, and the reasons given as due to accumulation of tolerances on retail deliveries (f.i. 30 lbs p. ton in the State of New York, 40 lbs p. ton in Pennsylvania), differences in car weights, but very often to absorption and loss of moisture. A few examples are cited. Ha. (2.03)

Vernier Automatic Weight Indicator. (Vernier Gewichtsanzeiger.) S. Klinghofer, Petroleum, Vol. 26, Sept. 3, 1930, pages 889-900.

Instrument of the Martin Decker Corp., Long Beach, Cal. E.F. (2.03)

Determination of Specific Gravity with the Bunsen-Schilling Apparatus. (Bestimmung des spezifischen Gewichtes mit dem Bunsen-Schilling-Apparat.) E. Gumann, Gas & Wasserfach, Vol. 73, Feb. 27, 1930, pages 176-178.

Mathematical treatment of the subject. Includes discussion. E.F. (2.03)

Should the Air Volume of a Pycnometer be Taken Into Account when Determining the Empty Weight? (Muss bei der Feststellung des Leergewichtes eines Pyknometers der Luftinhalt beruecksichtigt werden?) Prof. Dr. Schlueter, Chemiker Zeitung, Vol. 54, Sept. 6, 1930, page 698.

No. The dimension of the error is given. E.F. (2.03)

A Percentage Balance for Concrete Aggregates. W. J. Emmons. Engineering News Record, Vol. 106, Jan. 1, 1931, pages 37-38.

The balance has arms divided from 0-100 with sliding poises, the coarse aggregates are put on one side and sand on the other. The scale arm reads percentages directly. Ha. (2.03)

Pressure and Vacuum (2.04)

A New Instrument for Measuring Pressures in Mines. (Ein neues Messgeraet fuer Druckmessungen in Bergwerken.) E. Stach & H. Kirsten. Zeitschrift fuer Instrumentenkunde, Vol. 51, Feb. 1931, pages 106-107.

Sensitive instrument for the survey of ventilation currents in mines is described. Represents a modified Statoskope of the Askania Works. E.F. (2.04)

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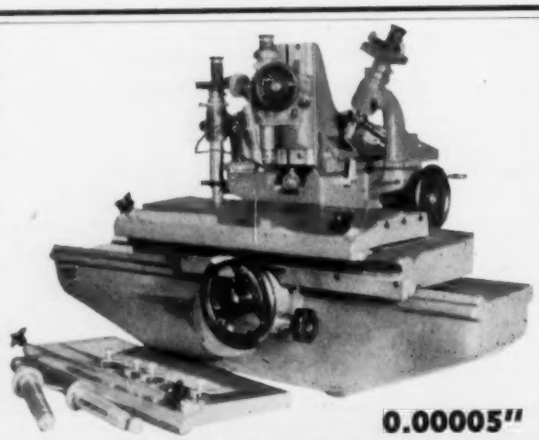

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A New Design of an Ionization Manometer. E. K. Taylor and H. W. Weinhart. Review of Scientific Instruments, Vol. 2, July 1931, pages 401-411.

The instrument is a vacuum gage designed for the measurement of the pressure of the residual gas in highly exhausted tubes of the order of 10^{-8} mm. Hg. Special attention has been given to the insulation so that the small positive ion currents can be measured. The determination of the gas pressure is based on ratio of the positive ion current to the electron current, which ratio, below pressures of 10^{-4} mm. Hg has been found to be proportionate to pressure, so that $p=Cip/ie$, where p is the pressure of the gas, ip and ie the positive ion and electron current respectively, and C a constant dependent on the gage. The tube is fully described, the operation and the determination of C explained. Ha. (2.04)

Investigation of the Diaphragm-Type Pressure Cell. Theodore Theodorsen. National Advisory Committee for Aeronautics, Synopsis of Report No. 388, 18 pages.

This report relates to various improvements in the process of manufacture of the N.A.C.A. standard pressure cell. Like most pressure recording devices employing thin diaphragms, they would in general show considerable change in calibration with temperature and also some change of calibration with time or aging effect. Some instruments exhibited considerable internal friction.

It was established that the temperature dependency of the stiffness was due to difference in the thermal expansivity between the diaphragm proper and the supporting body of the cell, and convenient methods for its compensation have been developed. The diaphragm is furnished with a small central bushing of a different metal, and it is possible to determine a size of this bushing which gives the diaphragm exactly the same thermal expansivity as the cell body. (2.04)

Apparatus for Determination of Changes in Gas Volumes at Constant Pressure. (Apparat zur Messung der Aenderung des Gasvolumens bei konstantem Druck.) V. Mayer. Chemische Fabrik, No. 10, March 5, 1930, pages 85-86.

Aims at the elimination of the changing atmospheric pressure. E.F. (2.04)

Ionisation Manometer for Low Pressure. (Ionisationsmesser bei kleinen Drucken.) R. Sewig. Zeitschrift fuer technische Physik, Vol. 12, April 1930, pages 218-221.

Application of the discharge method for high vacuum measurements by means of the ionisation manometer. Some fundamental objections against the testing method are discussed. E.F. (2.04)

On a Current Manometer. (Ueber ein Stroemungsmanometer.) W. Gerlach & H. Mayer. Zeitschrift fuer Instrumentenkunde, Vol. 50, Aug. 1930, page 481.

Instrument is based on a principle of high vacuum technique; i. e. that in case of low pressures, small pressure differences can be utilized for indicating and keeping track of currents. The sensitivity of the new instrument is illustrated by the fact that the Brownian movement can be demonstrated with it. E.F. (2.04)

Electrometric Measurements of Very Low Gas Pressures by Means of Ionisation Currents: The Space-Charge Manometer. (Elektrometrische Messung sehr kleiner Hochvakuumdruecke mit Hilfe von Ionisationsstroemen: das Raumladungsmanometer.) W. Molthahn. Zeitschrift fuer technische Physik, Vol. 11, Dec. 1930, pages 522-529.

Pressure down to 10^{-10} mm. of mercury column are measured by ionisation currents and by a single-thread electrometer. E.F. (2.04)

High-Pressure Manometers. W. Lange. Engineering Progress, Vol. 12, June 1931, pages 132-133.

The instrument is a hydraulic manometer with a tube of hardened steel; made by Schaeffer & Budenberg. Ha. (2.04)

Flow and Volume (2.05)

The Evaluation of Storage Tanks for Liquids. (Die Ausmessung von Lagerbehaeltern fuer Flussigkeiten.) W. Block. Die Messtechnik, Vol. 7, June 1931, pages 145-150.

The principal conditions are discussed which a storage tank for liquids has to satisfy so that its contents can be checked sufficiently accurately. The most important devices to ascertain the contents are indicating pipe and gaging rod. For marking their scales it is necessary to evaluate the tank which is most conveniently done by filling with definite amounts of liquid by means of a special measuring vessel, or for very large tanks by measuring the length, and calculation of the contents. Methods and apparatus are described fully and all corrections given; especially treated is the case of a horizontal cylinder with convex bottom. Ha. (2.05)

Electrical Distant-Indicating Water-Level Meter. (Elektrische Wasserstandsfernmelder.) G. Trossbach, Gas & Wasserfach, Vol. 73, Sept., 1930, pages 897-900.

After discussing the principles of the various types, the instruments of the Bloch Co., Dresden ("Aegir"), and of the Neufeldt & Kuhnke Co., Kiel, are considered at length. E.F. (2.05)

Nivelling Instrument With Adjustment of the Water-Level in the Field of View of the Telescope. (Nivellierinstrument von Otto Fennel Soehne mit Einstellung der Libelle im Gesichtsfeld des Fernrohres.) P. Werkmeister, Zeitschrift fuer Instrumentenkunde, Vol. 50, Sept., 1930, pages 554-555.

Device is described and measurements are reported on. E.F. (2.05)

Modern Gas Distribution and Gas-Meters. (Moderne Gasverteilung und Gasmesser.) Dr. Ludwig, Gas & Wasserfach, Vol. 73, Dec., 1930, pages 1201-1207.

Paper presented at the 71st meeting of the Deutscher Verein von Gas und Wasserfachmaennern, Stuttgart, 1930. E.F. (2.05)

THE REVIEW OF SCIENTIFIC INSTRUMENTS

CONTENTS FOR FEBRUARY, 1932, ISSUE

VOL. 3, NO. 2

Notes on Radiation Thermopiles.

An Oscillator for the Crystal of an X-Ray Spectrograph.

Tellurium-Bismuth Vacuum Radiation Thermocouple.

A New Type of Radiometer.

The Stroboglow.

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The Calibration of Water Meters in Poland. (Ueber die Eichung der Wassermesser in Polen.) A. T. Troskolanski. Messtechnik, Vol. 7, July 1931, pages 179-184.

Organization of the government department tests, instructions, and regulations for the manufacture are described and discussed. Ha. (2.05)

A Micromanometer of High Sensitivity. E. Ower. London, Edinburgh, and Dublin Philosophical Magazine and Journal of Science, Vol. 10, Oct. 1930, pages 544-551.

Gives detailed description of an instrument designed to measure low speed movement of air. It is based on the chattock gauge. In general the instrument consists of two cups similar to those used on the chattock gauge, with cup diameter 100 mm. A capillary tube of 3 mm. diameter connects the cups. Xylol was used as the manometric liquid. Pressure differences of 0.00001 inch of water could be detected. The instrument is intended primarily for laboratory use as a standard against which other instruments can be checked. RHP (2.05)

Measuring Large Flows of Water: (Flow in Silt-Laden Canal Gaged by Contracted Flume. R. L. Parshall; Determining Coefficients for Large Venturi Meters. S. F. Coghlan; A Practical Venturi Meter for Irrigation Service. J. E. Christiansen and I. H. Teilman.) Engineering News Record, Vol. 106, Jan. 29, 1931, pages 183-188.

The construction, calibration and operation of 26 large Venturi meters ranging from 30 to 72 in. in diameter is described and their performance curves given. These large meters are used for irrigation pipe lines. Ha. (2.05)

Automatic Burette for Measuring Mixing Water. F. V. Reagel. Engineering News Record, Vol. 106, Jan. 1, 1931, page 37.

The burette is connected with an overflow chamber; the accuracy is about 0.25 cm^3. Ha. (2.05)

New Formula for Friction Losses in Steel Pipe. Engineering News Record, Vol. 106, Feb. 12, 1931, pages 273-274.

From data of about 1200 observations, a new formula for calculating friction losses in steel pipe lines carrying water under pressure has been developed by F. C. Scobey:

$$H = Ks \times \frac{V^{1.9}}{D^{1.1}}$$

where H is the loss of head due to friction in ft./1000; Ks is a coefficient dependent on the pipe characteristics, such as plate thickness, type of jointing and age; V is the average velocity of water in ft./sec.; D is the average diameter of pipe in ft. The coefficient Ks varies with the age of pipe according to $Ks = K's\ e^{0.015} \times t$, where K's is the value for new pipes and t, years. Ks varies for different conditions between 0.38 and 0.52. A nomographic chart is developed for quickly determining H. Ha. (2.05)

The New Apparatus, Purifier, Gas Meter and Regulator of the Delmenhorst Gas Works. (Die neue Apparate-, Reiniger-, Gasmesser-, und Regleranlage des Stadtischen Gaswerkes Delmenhorst.) G. Franke. Das Gas- und Wasserfach, volume 74, May 2, 1931, pages 406-411.

Describes the old and new operating systems, the method of construction, the apparatus, the purifier, the gas measuring and regulating systems, and the boiler and heating systems. M.B. (2.05)

Coefficients of Discharge of Fuel Injection Nozzles for Compression-Ignition Engines. A. G. Gelalles. National Advisory Committee for Aeronautics, Synopsis of Report No. 373, 18 pages.

This report presents the results of an investigation to determine the coefficients of discharge of nozzles with small, round, orifices of the sizes used with high-speed compression-ignition engines. The injection pressures and chamber back pressures employed were comparable to those existing in compression-ignition engines during injection. The construction of the nozzles was varied to determine the effect of the nozzle design on the coefficient. Tests were also made with the nozzles assembled in an automatic injection valve, both with a plain and with a helically grooved stem. It was found that a smooth passage before the orifice is requisite for high flow efficiency. A beveled leading edge before the orifice gave a higher coefficient of discharge than a rounded edge. Varying the length-diameter ratio from 1 to 3 for one of the orifices having a beveled leading edge was found to have no effect on the value of the coefficient. The results with the nozzles assembled in an automatic injection valve having a plain stem duplicated those with the nozzles assembled at the end of a straight tube of constant diameter. Lower coefficients were obtained with the nozzles assembled in an injection valve having a helically grooved stem. When the coefficients of nozzles of any one geometrical shape were plotted against values of corresponding Reynolds Numbers for the orifice diameters and rates of flow tested, it was found that experimental points were distributed along a single curve. (2.05)

Slot Gas-Meter of the Gas Plant of Gelsenkirchen. (Muengasmesser beim Gaswerk Gelsenkirchen.) Schomburg. Gas & Wasserfach, Vol. 73, April 12, 1930, pages 333-334.

The slot gas meter is described with emphasis on its economy. E.F. (2.05)

Improvements in Water Meters. (Zur Verbesserung der Wassermesser.) E. Keil. Gas & Wasserfach, Vol. 73, Sept. 1930, pages 902-903.

Reports on experiments with four water meters for large quantities. E.F. (2.05)

The New Venturi-Meter Equipment in the Spring Areas of the City of Munich. (Die neuen Venturimessanlagen im Quellgebiet der Stadt Muenchen.) E. Henle. Gas & Wasserfach, Vol. 73, December 27, 1930, pages 1225-1232.

The abundantly illustrated paper shows the recent outlay. E.F. (2.05)

The Graphical Treatment of the Circular Weir. (Zeicherische Behandlung des kreisrunden Ueberfalls.) S. Gradstein & A. Walther. Gas & Wasserfach, Vol. 74, March 3, 1931, pages 223-225.

Solution by graphical integration. E.F. (2.05)

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Method for Calibrating Measuring Nozzles. (Verfahren zur Düsenmessung.) R. Mulsow. Glueckauf, Vol. 66, July 12, 1930, pages 943-945.

Water measurements with measuring nozzles. Formulae. Accuracy 0.5% if control measurement is carried out.
E.F. (2.05)

Investigation on the Uniformity of Rotating-cup Anemometers. (Untersuchung ueber die Gleichfoermigkeit des Umlaufs von Schalenkreuzanenometern.) J. Grunow. Zeitschrift fuer Instrumentenkunde, Vol. 51, March 1931, pages 144-151.

The anenometer factor, i. e. the ratio between wind velocity and r.p.m. of the anenometer should be constant for all wind velocities. In reality each instrument has its particular correction table. The author carried out exhaustive experiments to throw light upon the various sources of construction devices which exert an influence upon the anenometer factor.
E.F. (2.05)

Float-meters as Quantity Meters for Liquids, Gases and Vapors. (Schwimmer messer als Mengenmesser fuer Flusigkeiten, Gase und Däempfe.) A. Ruppel. Siemens-Zeitschrift, Vol. 11, June 1931, pages 290-297.

The theory and action of floats for the measurement of the flow of gases, liquids, and vapors in pipe lines are discussed and explained. The construction of float meters and their accessories, with special regard to the Bayer-Siemens meter, are described. This kind of meter is especially of advantage for pipes up to 200 mm. diameter; for larger pipe lines orifice instruments are preferable. Ha. (2.05)

Temperature (2.06)

Keeping an "Eye" on the Furnace. Machinery, Vol. 38, Oct., 1931, page 139.

Material evidently taken from a paper read before the American Chemical Society in Buffalo by Dr. L. R. Koller of the General Electric Research Laboratory. The photo-electric cell is directed at the furnace wall or some object within the furnace, from which different intensities of light radiate at various temperatures. When hot enough, the photo-electric cell cuts off the current or fuel supply.
R.H.P. (2.06)

Resonance Vibrations of Thermometer Mantles Caused by a Flow. (Struemungserregte Resonanzschwingungen von Thermometerhuelsen.) F. Michel. Die Messtechnik, Vol. 7, March, 1931, pages 59-63.

It has been observed that the mantles of thermometers for hot-steam suddenly break, although they were apparently sufficiently strong. By means of calculations and tests the reason was found in a periodical formation of eddies behind the mantle which set up oscillations of the tube at the natural frequency of the tube. An example shows how the frequency can be calculated. The best means for avoiding this trouble is to increase the wall thickness of the mantle and to make it as short as possible, and also to mount the thermometer in the direction of the flow instead of across it. Ha. (2.06.)

Old and New High-Temperature Measuring Instruments. K. Lennel. Engineering Progress, Vol. 12, Sept., 1931, pages 198-200.

A general survey of pyrometers now in use and their operation. Ha. (2.06.)

The Cross-thread Pyrometer, a New Partial Radiation Pyrometer. (Das Kreuzfaden pyrometer, ein neues Teilstrahlungspyrometer.) H. Gruess and G. Haase. Siemens-Zeitschrift, Vol. 11, June, 1931, pages 297-301.

The instrument uses the Holborn-Kurlbaum principle by comparing photometrically the brightness of the body to be measured with the filament of an incandescent lamp of definite temperature. Temperatures between 900° and 1800°C. can be measured; the measurements are made in the red range of the visible spectrum at 650 mu. The two filaments are kept constantly at 900°C. and a rotatable greywedge diminishes the brightness of the body to be measured to that of the filaments, which disappear at equal brightness in the bright background. A scale measures the rotation of the wedge and is calibrated in temperature. A little flashlight battery supplies current to the filaments, the whole is built into a little case of only 750 g; no reading of voltmeter or ammeter is required. The two filaments have different increase of brightness with current, but are easily adjusted to equal brightness, since one is a wide ribbon and the other, vertical to the first, is a wire broadened in the center. Only at one definite current value have both filaments the same brightness, which means a definite temperature (f.i. 900°C.), and one independent of the voltage of the battery. The instrument is particularly suitable for temperature measurements during operation or for checking. Ha. (2.06)

A New Temperature Regulator. (Ueber einen neuen Temperaturreglar.) L. Dubar. Elektr. Zschr., Vol. 52, July 30, 1931, pages 1006-1007.

This arrangement is especially useful for refrigerators and incubators, not so for very high temperatuses. The sensitivity of a bimetal thermostat is increased by addition of an auxiliary resistance acting directly on the bimetal strip and in series with the heating resistance. A great transformation of the movement assures the operating of the contacts at very small movements. The mass of the bimetal strip can be made very small. Ha. (2.06)

Bridge Connections for the Measurement of Temperature Differences with Electrical-Resistance Thermometers. (Brickenschaltungen zur Messung von Temperatur differenzen mit elektrischen Widerstands thermometern.) Wilh. Geyger, Archiv Elektrotechnik, Vol. 25, July 15, 1931, pages 476-482.

A new bridge connection is theoretically discussed and described in its practical arrangement, in which the deflection of the galvanometer is exactly proportionate to the temperature differences of two points. This could heretofore not be obtained with resistance thermometers. Seven references are cited. Ha. (2.06)

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Quotient Meter Connections for the Measurement of Temperature Differences with Electrical Resistance Thermometers. (Quotienten messerschaltungen zur Messung von Temperatur differenzen mit elektrischen Widerstand thermometern.) Wilh. Geyger. Archiv Elektrotechnik, Vol. 25, July 15, 1931, pages 483-488.

By using a modified connection of a cross-coil quotient meter, the author succeeded in making the deflection of the instrument independent of the decrease of deflection with increase of the individual temperatures, and to obtain an indication almost proportionate to the temperature difference. Theory and practical arrangement of the connection is given. Eight references are cited. Ha. (2.06)

Temperature Regulator for Melting Furnaces. (Temperaturregler fuer Schmelzofen.) H. Rechenberg. Elektrot. Zeitsch., Vol. 52, No. 49, Dec. 3, 1931, pages 1498-1499.

A platinum resistance in the furnace changes its resistance with the temperature and disturbs the balance of a Wheatstone bridge, of which it forms one leg. The galvanometer is deflected and closes, according to the direction of the deflection, the circuit of an amplifying tube which operates through a relay a resistance in the heating circuit of the furnace. A curve of a run at 850°C is given, which shows deviations of less than ± 1°C. Ha. (2.06)

A Large Constant-Temperature Bath Containing a Removable Glass Front. T. H. Tremearne. Industrial & Engineering Chemistry. Analytical Edition. Oct. 15, 1930, pages 426-427.

Principal features of this large bath are: a means of sealing the removable plate-glass front; a water-tight bushing through which a glass conduit tube is passed through the bottom of the case; and a special manometer mounting and clamp. Diagrams are given.—MEH (2.06)

Contribution to the Increase of Accuracy of Thermo-Electric Installations for Temperature Measurements. (Beitrag zur Erhoehung der Genauigkeit thermo-elektrischer Temperaturmessanlagen.) E. Otto, Zeitschrift fuer Instrumentenkunde, Vol. 50, Aug. 1930, page 485.

Publication refers to only one source of error, resulting from the resistance of the thermo-couple and of the lead wires. E.F. (2.06)

Instrument for the Determination of Thermal Expansion of Rigid Bodies at Elevated Temperatures. (Ueber einen Apparat zur Bestimmung der thermischen Ausdehnung fester Koerper bei hohen Temperaturen.) H. Gerdien & W. Jubitz. Zeitschrift fuer Instrumentenkunde, Vol. 50, Nov. 1930, pages 653-655.

The features of the equipment are reviewed. E.F. (2.06)

Thermometer With Division in Degree Celsius Only. (Thermometer nur mit Celsius-Teilung.) Glas und Apparat, Vol. 12, July 12, 1931, page 107.

The magazine advocates to finally standardize on the centigrade scale only for thermometers in order to abolish the present confusing and uneconomical conditions for manufacturers. Ha. (2.06)

The Siemens Temperature Regulator. (Siemens Temperaturregler.) W. Keil. Zeitschrift fuer Instrumentenkunde, Vol. 51, March 1931, pages 161-162.

The essential part of the time switch represents a bimetal strip heated by a small heating coil. By means of a screw the time interval can be regulated between 20 and 50 sec. E.F. (2.06)

An Air Thermostat for Quantitative Laboratory Work. W. H. J. Vernon. Transaction of the Faraday Society, Vol. 27, June 1931, pages 241-247.

Details are given of an air thermostat designed with the object of maintaining accurate control of temperature over comparatively long periods of time. Readings on a Beckmann thermometer placed in different positions over the whole working space of the thermostat (the working floor space which measures 79 in. x 30 in.), showed a maximum "spatial variation" of 0.015° at a controlled temperature of 25°C. Variations in point of time did not exceed 0.005°C. (observations extending over a working period of two weeks, with thermometer in fixed position in thermostat, outside temperature varied between 15.5 and 22.5°C.). A temporary disturbance, caused by opening a door of the thermostat to its fullest extent for three or four minutes, resulted in the temperature falling by 0.03°, and was completely eliminated in twenty seconds. W.A.T. (2.06)

Temperature Measurements in Oil Tanks. (Temperaturmessung in Oeltanks.) W. Moeller, Petroleum, Vol. 36, Jan. 30, 1930, page 11.

The simple device consists of a can containing a thermometer. The whole is lowered into the oil tank. E.F. (2.06)

Shielded Thermometers for High Temperatures. (Hochgradige Einschluss-Thermometer.) Dr. Siebert. Chemische Fabrik, No. 5, Jan. 29, 1930, page 34.

Range of thermometers is extended by utilization of Jena Supremaxglass of high melting point. E.F. (2.06)

Heat and Combustion (2.07)

Calorimetric Determinations of Thermal Properties of Methyl Alcohol, Ethyl Alcohol, and Benzene. E. F. Flock, D. C. Ginnings, & W. B. Holton. Bureau of Standards Journal of Research, May 1931, pages 881-900.

The method and calorimetric equipment previously used in the determination of thermal properties of saturated water and steam were applied, without essential modification, in an investigation of corresponding properties of methyl alcohol, ethyl alcohol, and benzene. Precautions were taken to obtain these liquids in a very pure state. Determinations were made in the range from 40° to 110°C., yielding values of latent heats of vaporization and changes in heat content. Empirical equations fitted to these properties aid in the interpolation, extrapolation, and application of the data. An estimate is made of the precision of the final results. A skeleton table of the more commonly used thermal properties of the saturated liquids and vapors has been prepared. Comparisons with the values of previous investigators are included. (2.07)

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Heat and Combustion (2.07)

Throttling Calorimeter Determines Steam Quality. L. H. DREDGE. *National Engineer*, Vol. 35, March 1931, pages 99-101.

The steam calorimeter is a device for determining the quality of steam, that is the proportion of dry steam in a water-and-steam mixture. It consists of three concentric tubes with open ends; the inner tube contains a thermometer and is filled with cylinder oil, the middle tube is the superheating chamber where exists the temperature indicated by the thermometer, and the outer tube is a steam jacket for the superheating chamber to prevent radiation from the latter. When steam is blown through the calorimeter the temperature is observed, and from it and the steam pressure in the main the quality can be taken from a chart containing gage pressure as abscissa and degree F. and heat content in B. t. u. per pound as ordinates. The efficiency of a boiler can be computed from $E = Ws \times Hs / Wc \times Hc$, where E = efficiency, Ws = weight in lbs. of steam generated, Hs = B. t. u. content of each lb. of steam, Wc = weight in lbs. of coal used, Hc = heat value of coal in B. t. u. per lb. Directions for making such calorimeters are given. Ha. (2.07)

Utilization of the Recess-Photometer for Determining the Percentages of Ashes in Coal. (Farbtonmessungen mit dem Stufenphotometer zur Bestimmung des Aschengehaltes von Steinkohlen.) W. GROSS & C. ABRAMSKY. *Glueckauf*, Vol. 66, Nov. 15, 1930, pages 1579-1582.

The utilization of the photometer in coal dressing is urged. Experiments under way already indicated that Fe in galenite can also be determined. E.F. (2.07)

Automatic Excess-Air Recorders for Boiler Furnaces. L. RUETGERS. *Engineering Progress*, Vol. 12, May 1931, pages 115-116.

The instrument records the actual oxygen content of the waste gases and thereby indicates the condition of the fire. A measured quantity of flue gas, mixed with a predetermined volume of reagent, is introduced into the combustion chamber in which the oxygen is burned by the action of a catalizer; the resultant reduction in volume is measured and indicated on a dial or recorded on a graph. The construction of the instrument is described fully; it is made by the Ados G. M. B. H., Aachen, Germany. Ha. (2.07)

Humidity and Moisture (2.08)

A Stirring Motor of Low Power Consumption in Vacuum Containing Case. (Ein vakuumdicht gekapselter Ruehrmotor mit sehr geringer Leistungsaufnahme.) J. LANGE, *Zeitschrift fuer Instrumentenkunde*, Vol. 51, March 1931, pages 153-155.

Motor for hygroscopic precision measurements. Temperature sensitiveness of wiring :10-3° C. E.F. (2.08)

Apparatus for Direct Water Content Determination. (Ein Apparat zur direkten Wasserbestimmung.) J. SEBELIEN, *Chemiker Zeitung*, Vol. 54, Sept. 6, 1930, page 698.

Brought on the market by the Nerlien kemisk-technisk Aktielskap-Oslo. Electric heating. Water condenses in glass measuring cylinder. Application mainly for determination of water content in fish, meat and similar products. E.F. (2.08)

Relay Hydro Balance. ("Hydro"-Relais-Waage.) E. K. H. BORCHERS, *Chemische Fabrik*, No. 8, Feb. 19, 1930, page 63.

Registers the course of absorption or evaporation processes. Compressed air transmission to secondary indicating or recording instruments. E.F. (2.08)

Power, Work and Output (2.09)

A New Torsion-Meter for Determining the Power Output of Shafts. H. D. BRASCH & A. V. GEHLEN. *Engineering Progress*, Vol. 12, July 1931, pages 149-151.

The instrument consists of a steel string under tension attached in a tangential direction to the shaft to be tested where it is subjected to additional tension in accordance with the torsional strain. The frequency of vibration of the string, made audible by electromagnetic means, indicates the extent of its total tension and hence the torsional deflection of the shaft. The theory of the method is explained and a formula developed for the calculation of the torque. The measurements can be recorded or plotted as curves. Ha. (2.09)

A New Dynamometer. *Automobile Engineer*, Vol. 21, Nov. 1931, page 531.

Messrs. Heenan and Froude, Ltd., of Worcester, have introduced a new "Froude" hydraulic dynamometer known as the P type, in which all vanes remain effective irrespective of load or speed. It is intended for aviation engines and is standardized for capacities up to 4,500 b.h.p. at 1,000 to 3,500 r.p.m. Construction and operation are described. RHP (2.09)

Physical Properties (2.10)

The Redwood No. 1 Viscometer. S. B. DICKINSON. *Instrument World*, Vol. 4, July 1931, pages 51-64.

A brief description of the construction and manipulation of the instrument which consists essentially of an oil-cup, having in the bottom an agate jet; a ball valve for starting and stopping the flow of oil; the whole surrounded by a water bath containing a stirrer to agitate the water. The specification has been standardized by the Institute of Petroleum Technologists (Great Britain). Ha. (2.10)

Dilution Viscosimeter. (Verduennungsviskosimeter.) J. TAUSZ & A. RABL. *Petroleum*, Vol. 27, Jan. 14, 1931, pages 41-43.

Viscosity measurements on diluted mineral oil and oil products. E.F. (2.10)

On a New Viscosimeter for Oil. (Ueber einen neuen Oelzaehigkeitsmesser.) H. SCHAFFER. *Petroleum*, Vol. 26, Sept. 23, 1930, pages 4-8.

Drop viscosimeter according to Schaffer. Similar to Engler's viscosimeter, but yielding results in CGS units. E.F. (2.10)

Pressure & Vacuum
Bristol Company
Brown Instrument Co.
Foxboro Co.
Tagliabue Mfg. Co., C. J.
Taylor Instrument Companies
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Taylor Instrument Companies
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Brown Instrument Co.
Tagliabue Mfg. Co., C. J.
Taylor Instrument Companies
Strain
Baldwin-Southwark Corp.
Alfred Suter
Tester
Baldwin-Southwark Corp.
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B. C. Ames Co.
Federal Products Corp.
R. Y. Ferner Co.
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General Electric Co.
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Foxboro Co.
Water Level for Boilers
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Wind
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General Radio Co.
Illinois Testing Labs., Inc.
Jewell Electrical Instrument Co.
Rawson Elec. Inst. Co.
Rubicon Company
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Electrical
Brown Instrument Co.

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GASOLINE METERS
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GASOMETERS

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Tagliabue Mfg. Co., C. J.
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GROUND-OHMER

GYPSUM TESTING INSTRUMENTS
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HELIOSTATS
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Littelfuse Laboratories
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Testing Devices
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Tagliabue Mfg. Co., C. J.
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Alternating

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Improved Vacuum-Tube Falling-Ball Viscometer. LEONARD F. MOORE & A. C. CUTHBERTSON. *Industrial & Engineering Chemistry, Analytical Edition,* Oct. 15, 1930, page 419.

Two variable condensers have been added to the circuit of Symmes and Lantz (Industrial & Engineering Chemistry, Analytical Edition, 1, 35, Jan. 15, 1929). MEH (2.10)

Convenient Accessories for Use with the Saybolt Universal Viscometer. CARL WINNING. *Industrial & Engineering Chemistry, Analytical Edition,* Oct. 15, 1930, pages 417-418.

An adaptor which permits testing small quantities of oil in the Saybolt Universal, and a 28.6 cc. Saybolt viscosity flask for oils of high viscosity, are described and recommended. MEH (2.10)

A Viscosimeter of E. Madelung Type for Small Quantities of Liquids. (Ein Viskosimeter fuer kleine Fluessigkeitsmessungen nach E. Madelung.) W. KEIL, *Zeitschrift fuer Instrumentenkunde,* Vol. 50, Nov. 1930, pages 647-649.

Tube of 1mm. diameter and 6cm. length with 50-80 mm^3 capacity, contains a glass body. The inclined tube is electrically rotated and the rising of the body between 2 stop marks in the liquid is measured. The formula for evaluation is given. The following advantages are claimed: 1) Small amount of testing liquid necessary; 2) short time of measurement; 3) simple method of evaluation. E.F. (2.10)

The Determination of the Elastic Constants. (Die Bestimmung der elastischen Konstanten.) G. BERNDT, *Zeitschrift fuer Instrumentenkunde,* Vol. 50, Nov. 1930, pages 624-638; Vol. 50, pages 678-692.

The subject is dealt with under the following headings: 1) The definition according to Hertz. 2) Discussion of the Matens mirror equipment. 3) Determination of the elongation, λ', dilatation ϵ', and modulus of elasticity, E, with telescope and scale. 4) Determination of λ', and ϵ' with autocollimation telescope. 5) The immediate determination of the ratio of transformation. 6) Determination of the reduction of area with an instrument according to Sieglerschmidt. 7) Modified instrument applied. 8) Measurements on 9 steels. 9) Literature. E.F. (2.10)

TESTING AND INSPECTION (3)

Physical Testing and Inspection (3.1)

New Testing Equipment. *Automobile Engineer,* Vol. 20, Aug., 1930, pages 296-298.

General discussion of recent improvements in machines fur ductility testing and balancing. Does not divulge details of the machines and is concerned only with those made by the Tinius Olsen Testing Machine Company. RHP (3.1)

Time Lag in Detonation Determinations. NEIL MACCOLL. *S.A.E. Journal,* Aug. 1931, pages 139-140.

In matching one fuel against another directly with a double-float carbureter, the knock sometimes either disappears or increases in intensity when the change from one fuel to the other is made. Results of a study of this subject, which was made recently, are presented in the paper. From the tests the conclusion is drawn that means should be provided to dry out the mixture between the carbureter and the cylinder-block of the engine used for antiknock measurement. Before a satisfactory answer to the problem can be reached, however, several other points require further investigation. (3.1)

Taking of Samples and Testing of Material for Rotors. (Probeentnahme und Werkstoffpruefung an Rotorkoerpern.) ERNST FRANKL. *Electrotechnische Zeitschrift,* Vol. 52, May 7, 1931, pages 600-601.

The stresses to which a dynamo rotor is exposed are discussed and the danger of fracture due to fatigue is pointed out. The fatigue fracture is explained as follows: The stress caused by rotation give rise to forces of motion within the structure which in time loosen up the crystallinic structure, and finally destroy it. Fine cracks are formed which become larger and wider until the stress for the remaining material becomes too great and a sudden fracture takes place. It is shown how and where samples of the forged piece should be taken, and which requirements the machines for testing such samples have to fulfill. A brief description of such machines is given. Ha. (3.1)

The Bridge Methods of Testing Welds. J. R. BATCHELLER. *Welding,* Vol. 2, May 1931, pages 308-312.

Describes the X-ray and magnetic testing method used by the Babcock & Wilcox Boiler Works for testing boiler welds. Ha. (3.1)

Universal Hydraulic Testing Machine with Pendulum Balance. A. O. KOSLOW. *Engineering Progress,* Vol. 12, June, 1931, page 128.

For tensile and fatigue tests; full description. Ha. (3.1)

Testing Stone by Means of the Sand-Blast. H. FABER. *Engineering Progress,* Vol. 12, Aug., 1931, pages 185-187.

For stones exposed to mechanical wear and tear, such as in stair-treads, floors, and road paving, this test offers a reliable and simple means for ascertaining their resistance. The testing machine, in which a sand blast from a given nozzle is directed under given pressure at the sample in a given distance, is described. Ha. (3.1)

X-Rays in Engineering. V. E. PULLIN. *Electrical Review,* Vol. 108, Jan. 9, 1931, pages 78-79.

The 2 fields where radiology is applied to engineering are: (1) Examination of castings, forgings, etc., to show flaws and lack of homogeneity in the structure, and (2) X-ray spectroscope investigation of metals to determine the fine structure and the modification it undergoes as a result of common engineering processes. All materials absorb X-rays; the denser the material, the more difficult it is to penetrate. The power of penetration depends on the voltage with which the X-rays are produced. While 4 ins. of Al can be penetrated by 40,000 volts, 4 ins. of steel require about 250,000 volts; the current consumption is of the order of about 10 milliamperes. The practice of X-raying, evaluation of photographs and explanation of structures are discussed at length. Ha. (3.1)

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METER TESTERS, Gas
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Taylor Inst. Companies
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Minneapolis-Honeywell Co.
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Bristol Company
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PHASE SEQUENCE INDICATOR
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PHOTO-ELECTRIC COLOR COMPARATORS
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Foxboro Co.
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Square Root
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Gaertner Scientific Corp.
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General Electric Co.
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Recording & Controlling
Brown Instrument Co.
Standard Cell Comparing
Eppley Laboratory, Inc.
Feussner Type
Eppley Laboratory, Inc.

The Influence of Shape and Magnitude of the Section of the Chip on the Result of Measurements of Cutting Pressures on Turning Tools. (Der Einfluss von Form und Groesse des Spanquerschnitts auf das Messergebnis bei Schnittdruck Messungen an Drehwerkzeugen). B. WINDMUELLER. *Die Mechanik*, Vol. 7, June, 1931, pages 150-152.

At first it is shown how the pressure exerted on the tool in cutting the material is resolved into three components: the principal cutting pressure acting vertically, the feed pressure acting in axial direction of the working piece, and the back-pressure acting in transverse direction to the axis of the piece, usually in the direction of the cutting tool. The arrangements to measure these pressures by Taylor, Schlesinger, Losenhausen, Okochi and Okoshi, and the measurement of the torque produced in cutting are described. It is shown that, because of the construction of these arrangements, shape and magnitude of the chip influence the result. The inaccuracy due to this influence can be reduced by taking into account the depth of the cut. Two examples illustrate the method. Ha. (3.1)

New Permeability Specimen for Comparison Tests. CLYDE M. CHAPMAN. *Engineering News Record*, Vol. 107, July 2, 1931, page 9.

The new specimen used for testing the permeability of concrete is of the bomb type with spherical cavity of definitely known area formed by a long-necked balloon filled with a known volume of sand. When the specimen is hardened the sand is washed out and the cavity cleaned with acid. Ha. (3.1)

Temperature and Humidity Control in Cement Testing. H. S. MATTIMORE. *Engineering News Record*, Vol. 106, Jan. 1, 1931, page 36.

In the Pennsylvania department of highways' testing laboratory a special moist air cabinet is employed for testing high-strength cement, which is especially sensitive to temperature and humidity conditions during testing, and keeps these two factors under strict control within the specified limits. Ha. (3.1)

A New 100-Ton Universal Testing Machine. *Engineering Progress*, Vol. 11, Oct., 1930, page 269.

Description of a machine suitable for tension tests on round and flat bars, chains, and cables, and for compression and bending tests up to a load of 100 tons. Hydraulic operation. RHP (3.1)

Radiographic Inspection with Gamma Rays. R. F. MEHL. *American Machinist*, Vol. 75 Aug. 13, 1931, pages 278-280.

The inspection of large finished pieces by X-ray is often impossible because of the cumbersome apparatus required. The Naval Research Laboratory, therefore, made some tests with radium. The γ-rays emitted from it have a much shorter wave length, about 1 x 10^{-10} cm. The time of exposure can therefore be reduced. The radium is held in a small capsule, or radium emanation (a gas which radium generates spontaneously) is enclosed in a glass and metal capsule. Both can be used with equal effectiveness. The method is shown on a large irregular casting where the radium could be brought to any desired place. This had not been possible with X-rays. Ha. (3.1)

A New Research Tool. R. F. PASSANO. *Pure Iron Era*, Vol. 9, No. 39, page 23.

The principle of the statistical theory is explained and its importance in applying it to research problems for evaluating test data is illustrated by means of an example. Ha. (3.1)

One Million Pound Testing Machine for Testing Wire Rope Specimens. TREVOR N. TREEN & T. AVERY. *Scale Journal*, Vol. 18, Oct. 1931, pages 3-4.

A detailed description of a machine for testing wire rope samples of 11 in. maximum circumference and 6 ft. unstretched length to a capacity of 1,000,000 lbs. The machine is equipped with autographic recording apparatus and electrically propelled and controlled poise. Ha. (3.1)

Hardness Testing Superhard Materials. A. F. SHORE. *American Machinist*, Vol. 75, Aug. 6, 1931, page 238.

Nitrided steels, tungsten and tantalum carbides can no longer be tested for hardness by the usual routine methods because of their immense hardness. Tests must be applied that disregard surface conditions and take a reading slightly below the surface. A chart is given showing, for different metals, the penetration depths and the force required for it. The penetrator is a hemispherical diamond. The method is described briefly. Ha. (3.1)

Testing of Concrete Protective Contings. (Zur Pruefung der Betonschutzanstriche.) P. MENCKE, *Tondindustrie Zeitung*, Vol. 55, March, 1931, page 322.

The author suggests some new testing methods. E.F. (3.1)

Tester for Internal Strains in Glass. (Glasspannungspruefer.) M. KNOPFF, *Glass & Apparat*, Vol. 11, Nov. 2, 1930, page 195.

Consists of 2 Nichol prisms, the sensitivity of which is increased by an optical device. Manufacturers: Pfeiffer, Wetzlar, Steeg & Reuter, Hamburg. E.F. (3.1)

X-rays for Investigation of Organic Materials. (Roentgenstrahlen zur Materialpruefung organischer Werkstoffe.) H. MARK, *Umschau*, Vol. 34, Oct., 1930, pages 866-868.

X-ray investigation of silk, textile products, dyes, rubber, etc. Various photograms are presented and the commercial importance discussed. E.F. (3.1)

Apparatus for Determining Deviations in Internal Diameters of Tubes. (Apparat zur Bestimmung von Abweichungen des inneren Durchmessers von Roehren und dergleichen.) *Petroleum*, Vol. 26, April, 1930, pages 430-431.

Pertains to an apparatus developed in the Research Laboratory of the Bataafsche Petroleum Maatschappij. E.F. (3.1)

Investigation on a New Apparatus for Testing the Lubricating Power of Oil. (Untersuchungen an einem neuen Apparat zur Beurteilung der Schmierfaehigkeit von Oelen.) R. VOIGTLAENDER. *Petroleum*, Vol. 26, April, 1930, page 5.

New apparatus developed in the Hydraulic Institute of the Technische Hochschule Muenchen under the direction of Prof. Dr. D. Thoma. E.F. (3.1)

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See Tachometers

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Production Testing and Inspection (3.2)

Electrical Testing Equipment. F. W. Hinrichs. *Automobile Engineer*, Vol. 21, Nov. 1931, pages 525-528.

Abstract of a paper recently presented to the Birmingham Branch of the Institution of Production Engineers. Advocates more thorough testing of automobiles both by instruments and by track tests. Particular attention is given to the use of the dynamometer for testing. Through its use defects in design can often be found and remedied before the car goes into service. RHP (3.2)

Automobile Spring Testing. Herbert Chase. *American Machinist*, Vol. 75, Dec. 10, 1931, pages 887-888.

A machine has been designed by E. Marlin of the Chrysler Corporation which automatically deflects each spring to a certain amount and sorts the springs according to the pressure required for this deflection. Sorting to within a pound limit is easily possible. Describes machine and its operation. Operator feeds springs in at timed interval and the machine tests and sorts into one of six possible classes. RHP (3.2)

"Guillotine" Test for Tires. *The Rubber Age*, Vol. 29, Aug. 10, 1931, page 412.

The Goodrich Rubber Co. subjects their tires to a test by letting a weight drop from 100 ft. height; the weight has a wedge-like shape. Each tire is subject to this test in several positions. Ha. (3.2)

Recording Contour Gage. E. C. Erickson. *American Machinist*, Vol. 75, July 23, 1931, pages 167-169; *Bell Laboratories Record*, Vol. 9, Aug., 1931, pages 567-570.

An optical arrangement is described for visual recording the variations in a plane surface, either of itself alone or in its relation to adjacent planes. This method was developed to ascertain the proper placement of telephone membranes. Ha. (3.2)

Rubber Problems Confronting the Automotive Engineer. R. K. Lee, *S. A. E. Journal*, June, 1931, pages 621-630.

Various tests and their results are discussed and the suitability of certain properties for given uses or the problems presented by them are explained. Considerable emphasis is laid on the importance of rubber manufacture procedure and of designing rubber parts, some outstanding examples being given of what not to do when designing shapes for molds. Considerable time and money can be saved in ways pointed out without adversely affecting the functioning of the part. (3.2)

Gaging to .00001 in. by Electric Measuring Device. *S. A. E. Journal*, Vol. XXIX, No. 6, Dec., 1931, pages 482-483.

This article is a report on a paper by Mr. H. M. Gustafson, of the General Electric Co., read at Seattle before Northwest Section of S. A. E. It describes an electrical gage useful for production measurement, and capable of magnifying contact point movement by 10,000 to 1.

The gage consists essentially of a contact point supported to move through a limited distance in the direction of measurement, say 0.005 in. This movement causes a pointer to travel a distance of 5 in. over the scale of an indicating instrument. Such magnification provides for easy factory inspection and control of manufactured parts within desired limits, and exact measurement of small distances. Electric gages have been built with magnification of 500, 1000 and 10,000, and magnification of 100,000 is possible. Multiplication of movement is obtained by unbalancing an electric bridge-circuit of four inductances. A 500-cycle alternator supplies power to a small transformer, which in turn supplies power to the four inductances. Two of these small inductance coils are located in the electric-gage head, which has dimensions of 5 x 2½ x 1½ in. The inductance of these two coils is varied by the movement of a pivoted steel-lever armature, one end of which moves between the coils as the contact point on the other end conforms to the surface of the piece being measured. The contact point is in the electric-gage spindle, which is made to fit the work. The other two inductances of the bridge, together with the 500-cycle alternator, the transformer and indicating instrument, are mounted on an indicating unit, 12" x 12" x 12" in dimensions, which is placed in easy view of the operator.

Long life of the spindle of the electric gage has been obtained by the use of appropriate materials; the bearing surfaces which support the piece to make the measurement independent of the human touch are of Carboloy, and the contact point which explores the piece is of diamond. The contact pressures are sufficiently low so that the material being gaged will not be scratched. Illustrations are given showing both units of the machine; also special forms of the gage head for measuring piston pin holes, exploring inside diameters of automobile cylinders, and one head for measuring two diameters and throw of a crankshaft. Continuous recording of measurements is made possible with an electric recorder adapted to the gage, which is also illustrated. This makes it possible to obtain automatically permanent records of the measurements. H.O. (3.2)

Testing of the Surface Conditions of Sheets. (Zur Pruefung der Oberflaechenbeschaffenheit von Blechen.) E. Gerold. *Stahl und Eisen*, Vol. 51, Jan. 22, 1931, pages 104-106. Report from the Research Department of the United Steel Works, Dortmund.

Various methods have been used to determine the luster of steel sheets. The lustre-meter after Kempf-Flugge and the Askania lustre-meter were used in these tests and compared with a method developed by the United Steel Works. The last mentioned method uses a photo-electric cell by means of which the lustre can be determined through the inclination of an electric measuring instrument. This new method is fit for routine shop testing and is preferable to the other methods mentioned above for scientific work. GN (3.2)

Laboratory Evaluation of Flex-Cracking Resistance. L. V. Cooper. *Industrial & Engineering Chemistry, Analytical Edition*, Oct. 15, 1930, pages 391-394.

A machine has been designed for laboratory evaluation of the flex-cracking resistance of any stock from which a dumb-bell strip may be cut. Results obtained on this machine on tread and sidewall stocks have always evaluated the flex-cracking resistance of stocks in the same order that actual road tests have. MEH (3.2)

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X-Ray Testing of Compressed-Gas Flasks. (Roentgenpruefung von Druckgasflaschen.) C. KANTNER & A. HERR. *Autogene Metallbearbeitung*, Vol. 24, June 1, 1931, pages 167-171.

Continuing a previous investigation, additional material has been collected to show defects in manufacture and violation of rules in manufacturing. A portable installation for shop tests is described. The whole X-ray outfit costs RM 6500; 15 flasks could be tested in one hr., including the taking of 15 exposures. The expenses for the testing of one flask amounted to RM 1.43, inclusive of films and chemicals. Ha. (3.2)

The Microscope for Production Control in the Small Plant. G. E. SHOEMAKER. *Iron Age*, Vol. 128, Oct. 29, 1931, pages 1100-1104.

The author explains and describes the advantages and possibilities of laboratory control of production by showing micrographs and macrographs of good and of defective metal specimens. He gives a layout of a little laboratory for simple metallurgical and chemical tests. Ha. (3.2)

Balance. CHESTER B. LORD. *American Machinist*, Vol. 75, Aug. 27, 1931, pages 331-334.

A comprehensive review of the methods of obtaining and testing balance in mechanical bodies is given with illustrations. Ha. (3.2)

A Mirror Comparator for Production Inspection. O. P. VAN STEEWEN. *American Machinist*, Vol. 75, Sept. 10, 1931, pages 417-418.

A combination of optical and mechanical transference produces a magnification of 1000: 1, so that an error of 1/1000 in. would show 1 in. deflection in the microscope. Arrangement of the device on the work piece is illustrated. Ha. (3.2)

A New Wheel-Flange Gauge. (Eine neue Spurkranzlehre.) C. CAESAR. *Organ fuer die Fortschritte des Eisenbahnwesens*, Vol. 85, May 1, 1930, pages 218-220.

A new wheel flange gauge is introduced and the advantages of the instrument are discussed. 3 ill. E.F. (3.2)

A New Testing Method for Thin Sheets. (Ein neues Pruefverfahren fuer Feinbleche.) E. SIEBEL. *Zeitschrift fuer Metallkunde*, Vol. 23, Feb. 1931, pages 64-66.

A deep-drawing machine according to Guillery for thin sheets is described. The deep drawing properties ϵ' of the material tested is evaluated by means of the following formula: $\epsilon' = \frac{d_B - d_0}{d_0}$, wherein d_0 = initial diameter of the drilled hole, d_B = diameter of the whole at the beginning of the rupture. 4 ill. 3 references. E.F. (3.2)

Improved Instrument for the Measurement of Threads. (Verbessertes Gewindemessgeraet.) F. GOEPEL. *Zeitschrift fuer Instrumentenkunde*, Vol. 50, Jan. 1930, pages 37-43.

The improved instrument is described and illustrated and the mathematical fundamentals given. E.F. (3.2)

Moisture-Proof Determination of Waxed Papers. CHAS. ALLEN THOMAS AND HERMAN J. REBOULET. *Industrial & Engineering Chemistry, Analytical Edition*, Oct. 15, 1930, pages 390-391.

Apparatus and method are described. Test requires two hours. MEH (3.2)

Lacquer Studies. I—Development of an Abrasion Test for Use with Nitrocellulose Lacquers. WILLIAM KOCH. *Industrial & Engineering Chemistry, Analytical Edition*. Oct. 15, 1930, pages 407-409.

The equipment, theory of development of the test, and the practical use of the proposed method for measuring abrasion of lacquer films are described. MEH (3.2)

Maintenance Testing and Inspection (3.3)

A New Testing Set. *Electrician*, Vol. 106, Jan. 23, 1931, page 145.

Dynameg, Ltd., of 41 Oriel Road, Bootle, Liverpool, Eng., puts out in 2 types a new testing set. No. 2 equipment contains a specially constructed generator which in conjunction with the switch on the side of the case, permit a.c. or d.c. use at will for testing purposes. It is fitted with 3 terminals, together with enclosed neon lamp or ohmmeter reading directly in megohms. The instrument, enclosed in an oak case fitted with leather carrying handle, serves the following functions: test lamp, polarity indicator, a.c. and d.c. indicator, circuit and line tester, earth tester, and insulation resistance tester. No. 1 type is cheaper, simpler, develops only a.c., without ohmmeter or switch, and will give only an approximate insulation test. It is designed principally for the use of wire-men, but serves as well as No. 2 except for insulation testing. WHB (3.3)

Location of Failure in Open Transmission Lines. (Fehlerortbestimmung in Freileitungsnetzen.) M. WALTER. *Elektrotechnische Zeitschrift, Zschr.*, Vol. 52, Aug. 13, 1931, pages 1056-1060.

The present status of methods and equipment for locating failures in overhead transmission lines is reviewed and a few recent measuring methods are described with their instruments. The determination of the place of breakdown is made either from observation of voltages or from the operating periods of relays with known time characteristic, or from both combined. A few examples illustrate the methods. Eighteen references supplement the paper. Ha. (3.3)

ELECTRICITY AND MAGNETISM (4)

Electrical Measurements and Instruments (4.1)

On the Measurement of High Resistance by the Bridge Method. J. A. C. TEEGAN. *Philosophical Magazine and Journal of Science*, series 7, Vol. 12, Oct. 1931, pages 840-843.

The difficulty in measuring resistances of a higher order than 10^6 ohms by the ordinary Wheatstone bridge method due to the small current in the galvanometer branch is overcome by using a thermionic valve with suitable high and low tension batteries in connection with a robust galvanometer. The method is described and illustrated by a few examples. Ha. (4.1)

EDITORIAL COMMENT

(Continued from Page A7)

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I am a subscriber to your magazine INSTRUMENTS and wish to advise you that at the present writing I have not received my January copy.

I note that it is published the 15th of each month and thinking that perhaps there may have been some unavoidable delay I have waited until today.

I am very desirous of getting all my copies as I find this magazine one of the best which has come my way in a long time and intend to have them bound for reference. I hope this explains my anxiety to receive my January copy.

February 1, 1932 — Albert O. Piper
Racine, Wis.

To the Editor of INSTRUMENTS:—

We wish to express our appreciation of the new INSTRUMENTS as represented by your January 1932 issue. The magazine is greatly improved and we find it of great interest in keeping us in touch with developments in the instrument field.

We note much improvement in the type of advertising material and the various items of particular interest to research laboratories. We appreciate such information as can be obtained from advertisements such as the C. J. Tagliabue Manufacturing Company on the inside front cover, the Burgess-Parr Company, Inc., page A1, Bausch & Lomb, page A7, and many others too numerous to mention.

INSTRUMENTS is becoming of more value to us because of these varied fields since it serves to keep us in touch with new instruments and uses of same which are so essential to the proper conduct of industrial research. Wishing you increased success and approving heartily of the improved appearance and utility of the new INSTRUMENTS, we are

February 2, 1932 — John J. Shank
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Daniel E. Krause
February 5, 1932 — Brillion Iron Works, Brillion, Wis.

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(Continued from Page 46)

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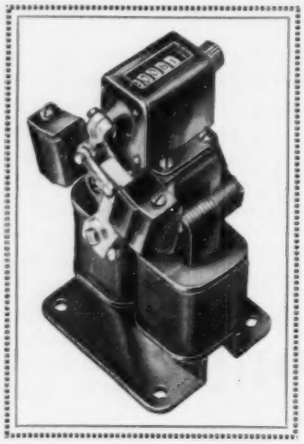

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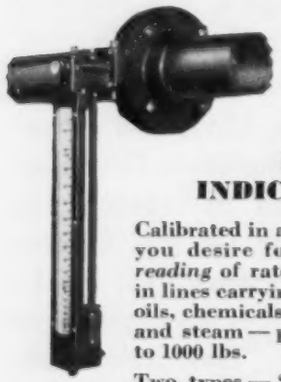

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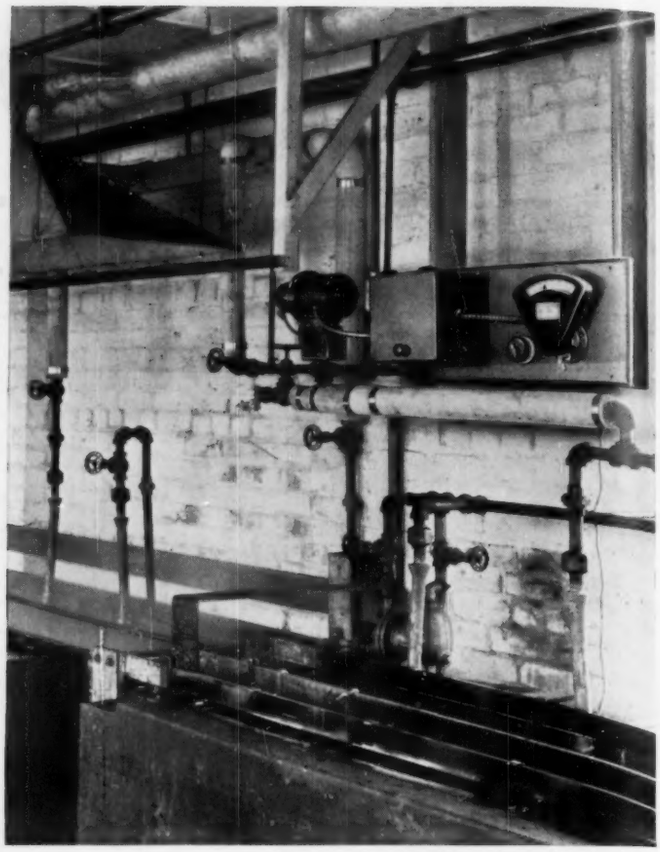

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